PHOTOGRAPHY

BY

DELAMOTTE

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THE

PRACTICE

OF

PHOTOGRAPHY,

A MANUAL

For Students and Amateurs;

BY

PHILIP H. DELAMOTTE, F. S. A.

TO WHICH IS ADDED

PHOTOGRAPHIC CHEMISTRY AND CHEMICAL NOTATION.

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1854.

PRACTICE

OF

PHOTOGRAPHY,

A MANUAL

FOR THE USE OF BEGINNERS;

BY

EDWARD M. ESTABROOK, M. A.

PREFACE.

HAVE been so frequently solicited by my friends and pupils to supply them with brief instructions in the various Photographic Processes, that I have prepared this little manual on a simpler plan than any other treatise I have met with, by endeavoring to carry the student directly through the various stages of each process, without distracting his attention by untimely digressions on the manufacture of chemicals or of apparatus—knowledge very useful in its place, but a stumbling-block when ill-timed. I have first described the Process on Paper, both for Negatives and Positives; then proceeding to Glass, I have given in detail every information connected with Collodion and Albumen, and I think everything essential to the attainment of a good photograph will be found mentioned. Amid the immense variety of formulæ and methods recommended by different experimenters, I have selected those which experience has assured me are the best under all circumstances; but in an art of such wonderfully rapid progress we must expect great improvements daily: these shall find place in future editions, should they be called for.

One feature in this work, which I hope will be found useful, is the description of the various chemical substances used in photography: instead of being introduced in the space devoted to the details of manipulation, they are grouped together at the end: for these, and for the general revision of the work, I am indebted to the kindness of Mr. THOMAS DELF, who undertook a task which the numerous demands upon my time forbade me fulfilling so carefully as the subject required.

P. H. D.

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INTRODUCTION.

(1.) PHOTOGRAPHY—a word derived from the Greek—signifies "to draw by the agency of light;" but as recent researches have proved that light is not the active agent through which the desired effects are produced, the word HELIOGRAPHY, or "sun-drawing," has been suggested as the more correct; yet, notwithstanding the inaccuracy involved, it will be more convenient, for the purpose of description, to retain the term "Photography," and to assume that light is the agent by which its results are obtained.

(2.) The art of Photography enables us to obtain upon paper, and other media, permanent impressions of the images of objects which are received in the focus of the camera-obscura.

(3.) This wonderful result, which but a few years since was regarded as a hopeless dream, has been realised through the labors of Daguerre, Talbot, Herschel, Hunt, and others engaged in scientific investigations, and already attained to a degree of perfection far outstripping the most sanguine expectations. But rapid and wonderful as have been its achievements, we think ourselves justified in still regarding the art in its infancy, for its processes and manipulation require a nicety and delicacy unknown in any other art whatever; while at the same time, the nature of the action of the chemical and other agencies employed is very imperfectly understood. We may, however, congratulate ourselves that the art of photography has now attained a satisfactory degree of simplicity and certainty; and that scarcely a week passes without some discovery being made which facilitates its operations.

(4.) Although it is desirable, for many reasons, to describe the practice of the art of photography without entering upon the discussion of the scientific principles involved, or the employment of technicalities, yet it must not be expected that while so many refined considerations are involved in its operations, success can

always attend the efforts of the photographer unless he pays to those principles the obedience they demand; he must, sooner or later, become acquainted with them. It is true that any one entirely ignorant of the theory or practice of chemistry, may, by a happy hit, succeed at once in producing a good picture; but as he knows not the causes of his success, or upon what it depends, he may meet with an overwhelming amount of discouraging failures without having the power to remedy them, or to trace their origin. It is true also, that patience and long-continued perseverance may supply the want of this knowledge; but it involves much loss of time and waste of materials. Nevertheless it must be admitted that recent improvements have so simplified the processes of the art, as to render chemical knowledge of much less consequence than heretofore. Therefore it will be our object in the following pages to present the details of each operation in such a shape as will be clear to the mind of any one entering upon the pursuit; while, at the same time, the *rationale* of each operation will be given in such form and language as will enable the beginner to test his position at every stage, and to trace and remove any impediments he may meet with. We do not propose to give a history of the art, having now nothing to do with past failures, but only with the successful results of a multitude of experiments all tending to one aim—the greatest excellence and expedition in obtaining good photographs.

ON THE PRODUCTION OF A PHOTOGRAPHIC PICTURE.

(5.) The production of a photographic picture depends upon the chemical action on various substances of a certain power *(Actinism)*, which exists in the rays of light in connection with two other powers, viz. the *luminous* and the *heating*, neither of which produces the same chemical change upon the materials submitted to their influence in the art of photography, as the *actenic* or chemical power does. It is not the object of our treatise to enter upon this abstruse portion of the subject, we must confine ourselves to the detailing of the best manipulatory processes, with such explanation of the scientific principles involved, as may enable the amateur to practice the art with intelligence and certainty.

(6.) The principal agent employed, after numerous experiments upon other substances, still continues to be iodide of silver, a compound of iodine with silver; a substance highly susceptible of the influence of light, which so acts upon, and alters the nor-

mal condition of its particles, as to set up a new action; and, by ffurther accelerating this action, we obtain the desired photoggraphic pictures. Our preliminary processes consist in:—

(7.) I. *In the Paper Process,*—Spreading upon paper a coatiing of one of the salts of iodine; the iodide of potassium being tthat usually preferred. *Or, in the glass process,*—Coating a sheet cof glass with iodised collodion, albumen, &c.

(8.) II. Bringing the surface of the prepared paper, or collodion, into contact with a solution of the nitrate of silver, by which decomposition ensues, and the iodide of silver is produced. The paper, or other medium, is now ready for the camera.

(9.) III. *Exposing the Paper or other medium in the Camera.* —Upon being placed in the focus of the camera, the varied light of the image acts unequally upon the prepared sensitive surface; and according to the degree of illumination of the various parts of the image, so the surface becomes, in the subsequent processes, more or less darkened: those parts which are most illuminated iin the object, producing the greatest amount of blackening effect upon the sensitive surface.

(10.) IV. *Developing the Image.*—The paper, or other medium, after having been submitted to the action of light in the camera does not exhibit any of the change which has taken place upon iits surface: the picture is invisible, until the developing agent is applied, which may be either gallic acid, pyro-gallic acid, protosulphate, or proto-nitrate of iron. This developing is a continuation of the action excited by light. When the light strikes upon the sensitive medium, it reduces the iodide of silver to a metallic state; and the chemical salts, gallic acid, &c., do but more rapidly perform the same change.

(11.) V. *Fixing the Image.*—This process consists in careffully removing from the surface of the medium all the iodide of ssilver, &c., which has remained unacted upon by the light; this iis accomplished by immersing it in a solution of hyposulphite of ssoda, which dissolves the undecomposed iodide of silver that has mot been acted upon, and renders the picture no longer susceptttible of the action of light.

(12.) Such, briefly, are the successive operations for obtainiing a negative picture, which serves as a type from which any ggiven number of positives may be obtained. But negatives on glass may also be converted into positives, as will be described iin the proper place.

(13.) The successful practice of the art of photography requires on the part of the operator the most scrupulous cleanliness and accuracy in the employment of every material requisite to

the process, and the most implicit obedience to the rules laid down in these pages for his guidance, for they are the results of much patient investigation on the part of a host of intelligent inquirers, who have successfully overcome difficulties which, could they have been foreseen, would have appalled the most patient and determined mind. Happily for the photographer who now commences his career, he can profit by this experience, and be spared the labor and expense of original investigation. The path for him is tolerably smooth, and should he be induced to examine carefully the abstruse philosophical principles upon which this fascinating art depends, he may in his turn become a contributor to its improvement and advancement. The humblest experience may sometimes furnish a suggestion which the most refined and cultivated investigator may have failed to arrive at.

APPARATUS AND MATERIALS.

(14.) The apparatus and chemical materials employed must be selected with care and judgment. The former need not be of the most expensive kind; all that is required is, that it should be capable of fulfilling the conditions imposed upon it by the requirements of the art. The chemicals must be pure, such as are prepared especially for the purpose; and to secure himself from disappointment and failure, the operator should purchase them only of respectable dealers in photographic materials.

(15.) Acetic acid, ether, and other preparations, vary in quality, and an inferior article cannot be substituted for one of the proper strength and purity.

(16.) Much of the time of early practitioners was wasted in the preparation of various materials, but now everything required may be bought, and in a few hours a perfect equipment obtained. The choice of these must of course depend upon which method of operating is adopted—whether on plain paper, waxed paper, or albumenized paper, or on glass covered with albumen or collodion. For operations out of doors, the waxed-paper process possesses advantages over every other mode of working, as little or nothing is required to be carried besides the camera and the prepared wax-paper.

THE CAMERA.

(17.) The choice of a camera will depend upon the purpose to which it is applied, whether for portraits or landscapes; the sizes varying from those about five or six inches square to others which

will give a picture of twelve inches square and upwards. The prices of cameras vary considerably, according to the quality of the lenses; as one with a single lens (meniscus) may be obtained for a few shillings, while others, with two achromatic lenses, manufactured by Voigtlander, Chevallier, Lerebours, or Ross,* are worth as many dollars. As good pictures may probably be obtained with one kind as another; the advantage of the two-fold achromatic arrangement is, that it concentrates the light in the image, and thereby accelerates the process, while it also gives that image tolerably free from spherical and chromatic aberration.

(18.) For landscapes and views generally, one lens, about three inches in diameter, of long focus, say from twelve to eighteen inches, is the most suitable.

(19.) For portraits, two achromatic lenses are necessary, each placed in a separate tube, one moving within the other, for the purpose of adjustment.

(20.) In a simple lens, that is, one composed of a single piece of glass, there are two foci: the one, where the image appears clearest and well defined—this is termed its apparent focus; the other, which is a little nearer to the lens, is the *chemical* focus, or where the greatest amount of chemical action takes place.

(21.) An *achromatic* lens is always composed of two pieces of glass of different dispersive powers; that is, the one has its chemical focus at a certain distance from the apparent focus; the other, also at a certain distance, but a little nearer to, or further from, the apparent focus, according to its form.

(22.) One piece of the achromatic lens consists of a double convex lens of crown glass; this disperses the rays too much, to correct which defect we add a *concave* lens of flint glass, which of itself would cause the dispersion of the rays to be too little; but these two lenses being put together, they correct each other, and unite the rays at very nearly the same point, making the chemical and apparent foci identical. By giving the proper form to the surface of these lenses a compound lens may be produced, which shall correct not only this *chromatic* aberration, but also the *spherical* aberration, or that which produces distortion in the image of an object. A lens which corrects both chromatic and spherical aberration is said to be *aplanatic*.

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* A decided preference is given by photographers in this country, as well as by foreign artists who come here, to the cameras made by C. C. Harrison, of New York. Mr. Ross's are said to be the best now made in Europe.—*Ed. P. A. Journal.*

(23.) It must always be borne in mind, that the nearer the lens is placed to the object to be copied, the larger the image produced in the focus, and the greater the distortion (68.) In portraits, where great concentration of light, and consequent rapidity of action is desirable, a combination of lenses producing a focus of five or six inches is the best; if the face is formed as near as possible in the centre of the lenses, the amount of distortion is so small as to be undiscernible; if any occurs in the accessories, it is of less importance (67).

(24.) It is usual to place in front of the lens a disc of brass, perforated in the centre with a hole of given diameter, capable of being removed to give place to others of different diameters; these discs are termed *diaphragms*, and their purpose is, to exclude the excess of light falling upon the lens, which would weaken the impression of the image; to diminish the spherical aberration; and to give a greater amount of distinctness to the image: but at the same time they exclude much light, and thereby lengthen the time of the operation; yet with lenses of large diameter they are indispensable: the greater the amount of light falling upon the object to be copied, the smaller may be the aperture in the diaphragm.

(25.) Another disc, called a *cap*, is used for shutting out entirely the light from the camera in taking a picture, and stopping the operation at once.

(26.) The interior of the camera must be carefully blackened by being lined with paper, velvet, or painted; whatever the material used, it must be deadened so as to *reflect* no light, but absorb all the rays not falling upon the prepared surface placed in the focus.

(27.) Great care must be taken to test the accuracy of the adjustment of the frames fitting into the place of the ground glass, so that the prepared surface falls exactly in the same place as that occupied by it, when the focus is ascertained; any deviation from which would cause distortion or vagueness in the impression (67).

(28.) *The Tripod-stand.*—In taking views the camera should be elevated upon a tripod-stand, to a height nearly equal to that of the eye of the operator.

(29.) In portraits, the lenses being of short focus, very small projections from the object produce great distortion in the image; it is, therefore, desirable to keep the various parts of the object as much as possible, in the same plane: for this reason, if the body is turned direct to the front of the lens, the head should be

turned on one side, so as to give the face in three-quarter view, or nearly in profile.

(30.) *Head-rests.*—In taking portraits it is advisable to place the head of the sitter against a head-rest. This little instrument greatly assists the keeping it in one position. Care must be taken that no part of it is visible in the picture.

THE OPERATING-ROOM.

(31.) Photography requires that its operations should be conducted in a room from which the daylight is either totally excluded, or admitted through a transparent yellow medium, such as stained glass, dyed linen, calico, colored paper, or similar material; or the room may be illuminated by a candle or screened gas-light; for it must always be kept in mind that it is through the agency of *light*, and its peculiar action upon the chemicals we use, that pictures are obtained; and whenever a sensitive preparation is exposed, if but for an instant, to its influence out of the camera, that change is in operation to the deterioration of the picture. Therefore, during every stage of progress in the preparation of the sensitive surface until it is finally fixed and rendered no longer susceptible of change by the action of light, we must carefully guard against any kind of exposure to its influence. A disregard of this condition is undoubtedly the cause of many failures which are attributed to other causes. The operations of light are very subtile and mysterious: recent researches show us that it is constantly changing the equilibrium of all bodies exposed to its influence and agency; part of them give *heat*, part light, and others a chemical action, or, as it is now called, *actinism*. It must suffice for our purpose to merely mention these, and remark that it is not by the agency of the *light* rays alone that the photographic pictures are produced; at present it is thought that the *chemical* or *actenic* rays are those which set up the change in materials operated upon; still it is most convenient for the purposes of description that we should continue to use the term *light* as the agent by which our operations are effected.

(32.) It is a great advantage to the photographer if his operating room contains a closet in which the materials can be put away out of the dust and obnoxious vapors always present in the atmosphere, and where he can suspend his sensitive papers while they are drying. A sink, or similar convenience, for washings and other operations, and an abundant supply of filtered water, is indispensable.

PHOTOGRAPHY.

(33.) The discovery of the art of photography is due to Mr. Fox Talbot, who, early in 1839, communicated to the world the result of his experiments, and an account of the processes by which they were conducted.* This discovery was so startling, and its capabilities so wonderful, that the whole scientific world was interested in them, and directed its attention to their development; with what result we need not enquire, for the evidence abounds on every side. It is due, however, to the memory of our distinguished countryman, Wedgwood, to state, that so long back as 1802, he was engaged with Sir Humphry Davy in attempting to fix the images of the camera-obscura. If he was unsuccessful, it was probably due to the imperfect state of chemical science at that period.

(34.) As Mr. Talbot patented his processes on paper, much ingenuity was exerted to discover other substances and other methods by which his results could be attained; and the researches of Herschel, Hunt, Archer, and others, have given us the cyanotype, chromatype, amphitype, and the collodion process, while, at the same time, they have greatly improved the processes of Mr. Talbot himself.

(35.) These various improvements enable us now to obtain good views, portraits, &c., on paper, in a space of time varying from a few seconds to an hour and a half; while on collodion and on albumen instantaneous exposure to the image in the focus of the lens is sufficient to obtain a good picture.

(36.) The negative pictures obtained on glass appear to possess a slight advantage in clearness and sharpness over those obtained on paper; but there are so many advantages in using the latter material, that all our skill should be directed in perfecting it. Probably our efforts would be best directed to the developing agents; the sensitiveness of the iodide of silver perhaps cannot be increased; and if, as is now supposed, the instantaneous action of light suffices to effect the change in this substance necessary to the impressing the image, it must result that it is only due to the imperfection in the developing agent that instantaneous pictures cannot be obtained also upon paper.

PROCESSES ON PAPER.

(37.) The processes on paper are two—the *dry* and the *wet;* the former is the most convenient, and that generally practised;

* See Appendix.

by some practitioners the latter is preferred: we shall here describe both processes, beginning with—

(38.) *The Dry Method.*—This process is deserving of the most assiduous cultivation; for its simplicity and ready manipulation give to it an advantage over all other methods; by it we can carry a stock of prepared papers to any distance, and after exposing them in the camera to the desired object, reserve the further stages of the process until we return to the conveniences of the operating-room. Whatever imperfections now exist in this method, and they are but few, will doubtless soon be overcome: the results obtained at the hands of several eminent photographers leave but little to desire; in fact, in many positive proofs it is difficult, if not impossible, to discover whether they have been obtained from negatives on glass or on paper.

(39.) The paper used for the negatives can be employed either waxed or unwaxed. As good results are obtainable from the one as from the other; the employment of the latter saves much trouble; and the proofs can be rendered transparent by waxing *after* they are developed.

(40.) The quality of the paper used is of vital importance in this process; it must be as thin as possible, but of perfectly homogeneous texture throughout.

(41.) The proportions of iodide of potassium and nitrate of silver in the solution employed differ much in the practice of various photographers; the best result is most probably obtained when the quantity of silver in the iodide of that metal is in excess, for true iodide of silver (that is, when these two bodies are combined in definite atomic proportions) is not acted on by light.

We now proceed to detail the processes with waxed-paper by the dry method.

WAXED-PAPER PROCESS.

(42.) I. *Selection of Paper.*—The early photographers encountered great and discouraging difficulties in procuring paper suitable for the purpose of their art, which now no longer exist. Good papers are easily obtained of various degrees of thickness, uniform texture, well-sized and glazed, both of English and French manufacture; some prefer the former, others the latter. The difference in their quality appears to consist in this—the English papers are hard and dense, owing to their being sized with gelatin, consequently the sensitive preparation does not penetrate its substance, but remains on the surface. They are, therefore, best fitted for positive proofs. The French papers, on

the contrary, are generally sized with starch, with which iodine enters eagerly into combination: they are usually thinner and lighter, and consequently better adapted for negatives; but both English and French papers are prepared for positives and negatives; and the photographer can select either without any reserve; only with this precaution, let him avoid using different papers as much as possible, for the difference in their manufacture causes them to be affected differently under the same treatment. If bought of an honorable dealer in apparatus, &c., there is little fear of an unsuitable material being offered for sale. All the success of manipulation may rest upon the quality of the paper.

(43.) Previous to using the paper, each sheet must be examined for spots and holes; if any such exist that sheet must be rejected. The demand for a fine material for the purposes of photography has become so extensive, that several manufacturers have devoted their attention to the preparation of a pure paper, and the result is all a photographer can desire. Among English manufacturers, Whatman, Nash, and Turner, are eminent; Lacroix, and Canson, freres, are the most eminent of those of France. Lacroix's paper appears to give the greatest rapidity, doubtless owing to its containing the largest quantity of starch. For waxing, thin paper will answer as well as thick, if of homogeneous texture.

PREPARATION OF THE WAXED PAPER.

(44.) Suitable waxed paper for photography has only just become an article of commerce; the preparation of it is troublesome, but worth submitting to from the great facilities it affords in promptly obtaining pictures (negatives). The mode of preparing it is as follows:—Take a daguerreotype plate, or polished steel or copper-plate, such as are prepared for the use of engravers, but larger than the paper to be waxed, and place it on a stand so that a gas-burner can be passed under and maintain it at a steady temperature; when the plate is sufficiently warm, rub it all over with a piece of clean white wax; then lay upon it carefully a sheet of the thin negative paper, so that no air-bubbles are formed, and as soon as it is penetrated by the wax, cover it with another sheet; have ready a second heated plate, upon which put a sheet of the unwaxed paper, and place upon it the two waxed sheets, cover them with a sheet or two of unwaxed paper, and allow the excess of wax to be absorbed by them, by which means any waste of wax may be avoided; repeat this operation so long as any excess of wax is absorbed by the

clean paper, and finally place it between several more fresh sheets, upon the clean hot plate, and pass over them a hot smoothing-iron until the whole excess of wax is removed. This operation is best performed by two persons, one to each plate; as the wax cools so rapidly when removed from the hot plate, much time is wasted in the manipulation when performed by a single person. The first plate being rewaxed, the paper used for absorbing the excess of wax is placed upon it, in order to become thoroughly saturated, and then removed and treated as before directed. The preparation of a hundred sheets in this manner is a good day's work.

(45.) The kind of paper best suited for waxing is a very thin quality manufactured by Lacroix, and Canson, frères: it contains a large quantity of starch, which increases its sensitiveness.

(46.) This waxed paper possesses some excellent qualities, which render it exceedingly valuable to the photographer. It is transparent, which enables him to perceive the smallest bubble of air that exists between it and the exciting solution upon which it is floated: it has become exceedingly tenacious, somewhat resembling vellum; and it will admit of a proof being left in the developing solution for a considerable time, without spotting or staining the solution; but, above all, it permits us to prepare sensitive paper with the nitrate of silver, and keep it ready for use during many days, weeks, or even months. This quality is of immense value for operations out-of-doors, since it is no longer necessary to carry a cumbrous and fragile array of bottles and dishes; a portfolio and a camera suffice for a long journey. The waxing also enables us to obtain much deeper blacks upon thin paper than we could were it not employed.

For the benefit of those who have not much time to spare, we may remark that waxed paper is now extensively prepared for sale, and may be obtained of most of the respectable dealers in photographic materials.

PREPARATION OF THE SENSITIVE PAPER.

(47.) To increase the sensitiveness of paper for photographic purposes, it is found useful to prepare it with a coating of some organic substances, which act upon the nitrate of silver with energy, and render it almost black. For this purpose, the French chemists have suggested sugar of milk and starch (175); this latter has the additional recommendation of entering into combination with iodine.

(48.) Starch exists in many vegetable grains, roots, &c.: the

best for the purposes of photography is obtained from rice, To prepare it, take—

Distilled water	3 pints
Washed rice	4 ounces
Isinglass*	½ ounce.

Boil them in a glass or porcelain vessel, and filter through a clean cloth. The boiling must only be continued so long as the grains of rice begin to break, and stopped before the water is thickened by the excess of starch. This liquid, to which the following ingredients are added, gives a good body to paper, and yields very excellent tones of black in the proofs.

Dissolve in one quart of this rice-water,

Sugar of milk	693 grains
Iodide of potassium	230 "
Cyanide of potassium	12 "
Fluoride of potassium	6 "

(49.) When these are dissolved, filter through a fine cloth, and preserve the liquid for use in a well-closed bottle: it will keep for a long time without deterioration. In cold weather, it should be made tepid before using.

(50.) To render the paper sensitive, put a quantity of the solution into a clean porcelain dish, and immerse in it the sheets of paper, one by one, removing the bubbles of air between each. As many as twenty sheets of paper may be prepared at one time, provided the liquid completely covers them: they should be left in the liquid from half an hour to an hour, according to the thickness of the paper.

(51.) When the waxed paper is placed in the bath of iodide of potassium, that salt appears to completely penetrate the wax and enter into combination with it; the greasiness of surface disappears, and the paper takes freely the solution of nitrate of silver. This action, however, does not take place immediately, but during the space of half an hour, or an hour, before the wax becomes decomposed.

(52.) At the expiration of that time, take up the mass of paper, and turn it so that the sheets which were lowest become uppermost; then hang them up separately by one corner to drain, and to the bottom of each sheet attach a piece of blotting-paper to facilitate the dropping of the fluid.

(53.) Two different kinds of paper should not be placed at one time in the bath. Paper sized with this fluid has a light

* Genuine isinglass is required—not the spurious substitute, *gelatine*.

violet tint, which is not objectionable, but, on the contrary, is useful in the subsequent operation, as it serves to show when the action of the nitrate of silver upon the iodide is completed.

(54.) Paper thus prepared is said to be iodized and insensible to the action of light but too much exposure decomposes the iodide of potassium, and precipitates the iodine upon the starch.

(55.) The liquid will serve for fresh paper as long as it lasts, taking the precaution to filter it after use.

(56.) Starch, insoluble in cold water, dissolves completely in boiling water; after it becomes dry, it is again insoluble in cold water. Advantage is taken of this property to apply it to paper, as above directed.

(57.) This preliminary preparation is applicable to paper for negatives, whether it is used waxed or otherwise.

EXCITING THE IODISED PAPER.

(58.) Have ready two or three porcelain or gutta-percha dishes, of a size sufficiently large to contain the paper; fill one with distilled water, into the other put the following mixture:—

Distilled water	1 oz.
Nitrate of silver	30 grains
Glacial acetic acid	35 "

The acetic acid to be added after the nitrate of silver is dissolved.

(59.) The iodized paper is to be taken carefully by its opposite corners, and laid dexterously upon the surface of the fluid in the dish, and all bubbles of air removed; let it remain about five minutes, or until the surface which was tinted with the iodine has become white by the action of the nitrate of silver; then remove the paper to the dish of distilled water, and immerse until the water contains all the sheets submitted to the action of the silver. If the paper is not required for immediate use, it should be washed in another portion of distilled water. The water used in these washings contains a quantity of nitrate of silver, and should not be thrown away, but preserved for a subsequent operation—the developing, which will be explained hereafter.

(60.) After the washing, each sheet of paper must be drained for a few moments, and afterwards dried between folds of blotting-paper, and preserved in a portfolio out of the light. The whole of this operation above described must be performed by candle-light.

(61.) Unless the paper is washed once or twice in distilled water, it is nearly certain to become stained, even when kept in

a portfolio, out of the reach of daylight. This discoloration is caused by the undecomposed nitrate of silver; there is no danger of removing the sensitive iodide of silver by the repeated washings, unless the surface is rubbed, as that salt is insoluble in water; the nitrate, on the contrary, being soluble, is removed by the action of the water.

(62.) The operator must be careful not to touch any part of the paper with his fingers, except the corners by which it is held.

(63.) This paper will retain its sensitiveness for three or four weeks, or even more, if carefully prepared; hence it becomes exceedingly valuable to the traveler, as it enables him to dispense with many delicate manipulations which are performed with difficulty out-of-doors; and the "developing" may be deferred until it can be practised in-doors.

EXPOSURE IN THE CAMERA.

(64.) In selecting a view for a photographic picture, much care, taste, and skill, should be exercised; and in the hands of one who possesses an artistic feeling, the results are often truly wonderful. In varying the attitude in a portrait, or point of view in an architectural subject, or a landscape, the artist will select such as are most conducive to picturesque treatment, equally avoiding large masses of strong sunlight or deep shadows. A sky in which the sun is obscured by large white clouds is the most favorable. Violent contrasts of light and shade are not suitable for photographic views; they give a heavy, blotty appearance, the contrast between the lights and shadows being too powerful. It is only in the hands of a true artist, or man of taste, that pleasing results may be looked for. He who proceeds mechanically in his task may, by a fortunate accident, produce a good picture; and we have abundant evidence to show us that the mechanical treatment of nature is the most common and the least successful. It is in the hands of artists that photography will attain its highest excellence, to whom the attainment of *effect* is intuitive, while they themselves will acquire much valuable instruction from studying its results. Notwithstanding the microscopic accuracy of detail presented in a good photograph, its chief value and excellence will be found to consist in its sacrificing certain details, and in its representing *masses* of light and shade, the more striking and curious from being devoid of color. In this country, at present, the value of these productions, in an artistic point of view, is scarcely recognized;

while in France, Italy, Germany, and America, they have long ago occupied the portfolio of the cognoscenti and the atelier of the student in art.

(65.) If the view selected to be taken consists of near objects, such a position should be chosen as will present all the objects included in the view as nearly as possible in the same verticle plane; for if the focus of the lens is adjusted to a distant object, the near ones will be confused and distorted. With distant objects, and a lens of long focus, this defect is diminished.

(66.) The colors of the objects in the view must be taken into consideration—remarking, that blue, white, and such light colors, operate more upon the sensitive surface than green, red, or yellow: if violent contrasts of these colors present themselves unfavorably, the point of view should be changed.

(67.) The focus carefully adjusted, it only remains to place the sensitive-paper in exactly the same place occupied by the ground-glass upon which the image was received. When this is once correctly ascertained, no further concern need be taken respecting it. We only mention it, because in some cameras, "made to sell," no care is taken to adjust this plane. The interior of the camera should be kept scrupulously clean, any particles of dust in it carefully wiped out; the lenses, also, should be wiped with a piece of wash-leather, and the camera placed in "position" before a picture is taken, so that its temperature may become uniform with that of the surrounding medium. If it should happen to be colder than the atmosphere, a deposit of moisture may form upon the lenses and glass of the frames, by which a complete obscuration of the image would occur.

(68.) The lenses of the camera are placed at the extremities of two tubes, traversing within each other, for the purpose of adjustment of the focus. Two lenses, each of long focus, when placed together, or nearly so, produce an image at a shorter focus than either would separately, and with a greater concentration of light at the focus, but of smaller dimensions: this property renders the employment of two lenses favorable for taking portraits. For landscapes and views, a single lens, either compound *(achromatic)* or simple, is generally preferred; for if there is less intensity of light, this deficiency is compensated for by diminished spherical aberration (21).

(69.) If the operator requires to take both portraits and views, it is more convenient to have two cameras, one much smaller than the other; that for portraits need not be larger than will admit of its carrying a frame of 7 inches by 5, or thereabouts. That for landscapes, &c., may be 15 to 18 inches, by

10 to 14, according to the power of the lens. One set of lenses will do for both cameras, the single lens for views, the two-fold arrangement for portraits: but with this precaution, whereas in taking portraits the *convex* side of the lens is presented to the object; for views, the concave side must be turned in that direction.

(70.) If the lens employed is a simple one of the best form *(meniscus)*, it will be necessary, after adjusting it to the apparent focus, to move the frame that carries the ground-glass a little nearer to the object, in order to place it in the chemical focus, where the action on the sensitive paper takes place.

(71.) It is not possible to give any rules for the length of time the prepared paper should remain exposed to the action of light in the camera. This exposure is governed by—

1. The amount of light illuminating the object taken.
2. The color and distance of that object.
3. The degree of sensitiveness possessed by the prepared paper.
4. The size of the aperture in the diapragm.

(72.) With paper prepared according to the preceding formula, and a lens of twelve inches focal length, and a diaphragm with an half-inch aperture in front of it, one to two minutes, on a bright, sunny day, will suffice; but on a dark, gloomy day, seven to ten minutes may be requisite. We are sanguine in our belief that photography on paper will not stay its progress until it produces a sensitive surface, and a developing agent, which will give an image on an instant's exposure.

(73.) With a double (twofold) lens, and paper prepared as directed, a portrait may be obtained on a clear, bright day, in thirty to sixty seconds.

(74.) After the paper has been exposed so long as may seem necessary in the camera, it must be removed to a dark chamber, to be submitted to the developing agent; for as yet no impression is visible upon its surface. To avoid disappointment, it will be advisable, in commencing, to take two or three proofs of the same view, with different degrees of exposure in the camera.

DEVELOPMENT OF THE IMAGE.

(75.) Take a clean dish, capable of containing an inch in depth of fluid, and pour into it sufficient of the following solution to completely cover the paper:—

Distilled water	1 pint
Gallic acid	20 grains
Silver solution*	1 oz.

* The water used for washing the sensitive paper before mentioned (59).

(76.) Immerse the proof completely in this solution, and watch its progress at intervals: if the time in the camera has been well considered, the development will take place in ten or fifteen minutes; otherwise it may require many hours. As soon as the image is fairly out, remove the proof to a porcelain or glass slab, and wash it freely, rubbing a camel's-hair pencil or the finger lightly over the back of the proof, to remove any crystalline deposit which might leave spots. It must then undergo the "fixing" operation, which is effected by dissolving out the unchanged iodide of silver by hyposulphite of soda (164).

(77.) The appearance of a proof after development will serve to guide the operator as to the length of exposure in the camera. If the time has been too short, the appearance of objects in the proof will be feeble and indistinct. If the exposure has been too long, or the quantity of light admitted into the camera too great, the whole proof will become darkened, sometimes unequally; in which case the time of exposure for the next picture must be abridged, or the aperture of the diaphragm diminished.

(78.) If the time of exposure has been too short, the defect may frequently be completely remedied by leaving the proof in the developing-bath a longer time. It would appear that an action is set up in the iodide of silver the instant the rays of light fall upon it; and could we but find a developing agent that would act with sufficient energy, this instantaneous exposure in the camera with prepared paper would be as effectual as it is with iodised collodion. But the longer, within certain limits, the paper remains in the camera, the quicker the developing process can be performed. For instance, if one sensitive paper is exposed to the camera twenty seconds, and another fifteen minutes, the first will, perhaps, require a day and night's immersion in the gallic acid developing solution, while the latter will be fully developed in an hour.

(79.) The action of the gallic acid is accelerated if the solution be warmed before the proof is immersed in it.

FIXING THE NEGATIVE PROOF.

(80.) The object of this operation is to fix the impression on the paper, by removing the iodide and other salts of silver. These are insoluble in water; we have, therefore, to seek a convenient solvent—one which will dissolve these salts of silver, and at the same time not injure the impression already depicted on the paper. Nothing has been found better adapted for this purpose than the hyposulphite of soda (164). Take

Filtered rain or river water	1 pint
Hyposulphite of soda	½ ounce.

Pour a sufficient quantity of this into a dish, and immerse the proof in it, watching carefully the disappearance of the iodide from its surface, which can be ascertained by the disappearance of the yellow tint. This will take from a half to three-quarters of an hour, in some instances; but, with well-waxed paper, ten to fifteen minutes will be found sufficient. The change the proof undergoes in this operation is quite marvellous; the "darks" acquire an intensity, and the "lights" a brilliancy, truly astonishing.

(81.) The hyposulphite solution should be filtered after each proof has been fixed: it will serve many times, but only one proof at a time should be placed in it.

(82.) The proof should next be placed in a dish of clean water, and washed with a camel's-hair brush; and after being immersed for half an hour or so, rinsed in several waters, and hung up to dry. It is now unalterable in the light.

(83.) If the waxed paper loses its transparency, and presents a mottled appearance, as it generally does at this stage of progress, it must be held before the fire until warmed, then placed between two sheets of blotting-paper, and a warm smoothing-iron passed over it. This will completely restore its transparency.

THE WET METHOD.*

(84.) This can scarcely be carried on out-of-doors away from the resources of the operating-room; but where circumstances will admit of its being employed, very fine results can be obtained. The paper is prepared in the same manner as in the dry process, and may be either waxed or unwaxed.

(85.) 1. Immerse the papers in the solution of iodide of potassium.

(86.) 2. Float them upon the aceto-nitrate solution for about ten minutes.

(87.) Have ready a sheet of glass which fits accurately to the frame of the camera, and lay upon it a piece of smooth white blotting-paper, previously dipped in clean water: this is to receive and keep moist the sheet of sensitive paper, which must be carefully laid upon the blotting-paper, sensitive side uppermost, of course; it is best to pour over the blotting-paper a gentle

* See Appendix.

stream of water, so as to float the sensitive paper, and by carefully tilting the glass plate, allow the excess of water to drain off. When the water ceases to drop, the glass-plate, with the sensitive paper, may be removed to the camera and exposed to the image in the focus of the lens.

(88.) Some practitioners place this wet sensitive paper *between* two plates of glass while in the camera; but there is no necessity for so doing, while, at the same time, there is risk of disturbing the true focus.

(89.) 3. The necessary exposure in the camera being completed, the views are to be *developed* by the saturated solution of gallic acid, as described in the dry method.

(90.) 4. The *fixing* is accomplished in the ordinary manner, by the solution of hyposulphite of soda, and the negative proof can then be waxed.

(91.) The action of light is much more rapid upon the wet paper than upon the dry.

POSITIVES.—THE PRINTING PROCESS.

PREPARATION OF THE POSITIVE PAPER.

(92.) The paper for positives must be selected with the greatest care; every sheet containing holes or spots should be rejected. We give the preference to a good thick English paper, not too highly glazed. Cut it the required size, and make a pencil mark at the corner on the back. Then pour into a clean porcelain dish the following solution:—

Distilled water	1 pint
Hydrochlorate of ammonia	1 ounce.

Place a sheet of paper on the surface of the solution, and float it carefully so that the back of the paper does not become wetted. After a few seconds lift it off, and, holding it up against the light, examine if the whole surface is completely wetted: this result is secured if the paper has previously been placed between some sheets of clean damp blotting-paper, which renders it more susceptible to the absorption of the water when placed in contact with it. Leave it on the solution three or four minutes; take it out, let it drain until it ceases to drip, then dry by pressing it between some leaves of blotting-paper on a smooth table.

(93.) It is now impregnated with the hydrochlorate of ammonia (161); the object of this preparation is to produce a chloride of silver, by decomposing the nitrate of that metal in

the next stage of the process, which must be performed by candle-light. Have ready another dish, into which pour sufficient of the following solution to cover the bottom:—

Distilled water	1 ounce
Nitrate of silver	60 grains.

Place upon it a sheet of paper prepared as above directed, first rubbing it with a piece of blotting paper to remove any crystals of the hydrochlorate, carefully avoiding to wet the back. The time which it should be allowed to remain will depend upon the tint required in the proof. A short time will yield red tints; a longer, dark brown, violet, or black tints. Hang up the paper by one corner to drain, and when dry preserve it for use in a portfolio, between leaves of blotting-paper.

(94.) Paper thus prepared will remain white some six or eight days, after that time it generally begins to turn brown. Paper submitted to the first solution can be kept any length of time before being submitted to the silver solution. The second part of the operation should be performed the evening before the paper is required for use.

(95.) A quicker mode of preparing this positive paper is by coating it with the ammonio-nitrate of silver, as suggested by Dr. Alfred Taylor, as follows:—Make a solution of nitrate of silver, of the strength of thirty-five grains to the ounce of distilled water; add to it gradually, drop by drop, a strong solution of ammonia, a copious precipitate falls; continue to add the solution of ammonia until this precipitate is just re-dissolved: the paper is floated upon this solution as directed for the other (92).

POSITIVES ON ALBUMENIZED PAPER.

(96.) *Albumenized Positive Paper.*—Positive proofs taken upon paper coated with a film of albumin (143) attain a brilliancy of effect by a softening of the glaring white of the lights, with a transparency in the shadows, which cannot be arrived at by any other means. They are defective only when the albumin is applied too thickly. Take of

White of eggs	8 ounces
Distilled water	8 ounces
Dry salt	2 ounces.

Beat the whole together into a froth with a wooden spoon or fork. Take the froth as it runs, and put it into a basin; let it settle for twenty-four hours. It is then fit for use. Pour suffi-

cient quantity into a dish, and float a sheet of paper upon it for three or four minutes; hang it up to dry thoroughly; then place it between two sheets of glazed paper, and pass a smoothing-iron, moderately heated, over it: keep in a portfolio for use.

(97.) Paper thus prepared is excited by placing the albuminized side upon a bath containing the following solution:

Distilled water	1 ounce
Nitrate of Silver	120 grains.

Let it remain in contact about four or five minutes; then hang it up to dry, and preserve it out of the influence of light.

PRINTING PROCESS.

(98.) *Positive Proofs.*—To obtain a good positive proof is the aim and end of all our previous operations. Success in this result demands that our negative should be as perfect as possible. The process has been called *printing*, perhaps as good and as expressive a name for it as any other. The printing apparatus consists of a frame fitted with a thick plate glass, and a wooden back with screws, capable of exerting considerable pressure to bring the plates, or paper negative in close contact.

(99.) Place the back of the negative proof upon the plate of glass. Then lay upon it the positive paper, the prepared side upon the face of the negative, and cover it with a piece of black velvet or cloth: then shut down the wooden back, and turn the frame up, and place it perpendicular to the sun's rays, or expose it to the diffused light of day. In order to ascertain when it is sufficiently darkened, a piece of the positive paper should be allowed to project beyond the negative, and by watching the changes in this, a tolerably safe conclusion may be arrived at.

(100.) The intensity of the negative will, however, require to be taken into consideration. A little practice soon enables the operater to work with some degree of certainty.

(101.) In this climate, where sunlight cannot often be reckoned upon, it becomes exceedingly desirable that the positive paper should possess a high degree of sensitiveness. That prepared with the ammonio-nitrate of silver, as suggested by Dr. Taylor, appears to be more sensitive than any other we have employed (95).

FIXING THE POSITIVE PROOF.

(102.) The proof thus developed requires to be "fixed." This is accomplished by washing off the undecomposed nitrate

of silver with the following solution, according to M. Le Gray's formula:—

Filtered rain-water	1 pint
Hyposulphite of soda	3 oz.

(103.) In another vessel make a solution of nitrate of silver, thirty grains to one ounce of water. When it is dissolved, add a saturated solution of chloride of sodium, which causes a white precipitate to fall; carefully decant the liquid, and spread the precipitate at the bottom of the vessel, and let it blacken in the sun; then add it to the hyposulphite solution, which dissolves it. The object of this addition is to make a new solution of the hyposulphite of soda act as promptly in producing good "blacks" as it would if old. Every proof washed in the hyposulphite solution contributes a quantity of chloride of silver; therefore in course of time it becomes strong and thick; it must not be filtered; but a fresh supply of simple solution of hyposulphite added, when, if allowed to repose, it will again become clear.

(104.) The positive proof being placed in the above mixture, will acquire almost any degree of dark tone that may be desired, from red-brown to violet or black. A little practice will make the result easy and sure of attainment. The time required varies from one hour to three or four days.

(105.) Heating the hyposulphite solution will accelerate the operation of fixing; but it is attended with some risk, and where the proof is of value should not be attempted.

(106.) When the proof has attained the tone desired, remove it from the solution; place it on a slab of porcelain or glass, and wash it repeatedly until the paper is tasteless; the hyposulphite of silver is intensely sweet, and the smallest quantity may be detected by the tongue. Hang the proofs by one corner to drain, and then dry them between folds of blotting-paper.

If the positives have not been taken upon albuminized paper, they can now be washed with a mixture of equal parts of white of egg and distilled water, applied with a flat camel's-hair brush. When dry, place them between two pieces of glazed paper, and pass a hot smoothing-iron over, which will render the albumin insoluble.

The rich dark violet tint, so much admired in many French pictures, is derived from the use of sel d'or, or hyposulphite of gold (151). Make a bath of

Distilled water	2 ounces.
Sel d'or	1 grain;

immerse the proof therein, keeping it moving about, and as soon as the desired tint is obtained remove it, and let a stream of water flow over it, until the proof is perfectly freed from the undecomposed salt.

The solution of gold is precipitated upon the salt of silver reduced by the action of light, while the parts unacted upon remain intact.

COLLODION PROCESS ON GLASS.

(107.) Materials.

Plates of Glass, to fit the slide of the camera. A pure white glass has lately been manufactured for photographers, which will be found to possess many advantages. The glass plates must be perfectly flat, without scratches or air-bubbles. Beginners who buy large cameras are advised to purchase frames fitting into the slides which will carry smaller plates of glass: as they are more easily operated with, and less collodion is spoiled.

Bath of Gutta Percha or of Glass, to contain the nitrate of silver solution, in which the glass plates are plunged. The bath must be a little larger than the plates.

Glass Dipper, with which to hold the glass plate when dipped into the bath.

A large Dish, or sink, over which the washing operations may be performed.

Levelling Stand, on which to lay the glass plate during some of the operations.

A Pair of Glass Scales, with grain, scruple, and drachm weights, with which to weigh the chemicals.

Glass Measures, graduated to 3 oz. or more, to measure the quantities of water, &c.

Glass Measures, small, with which to pour on the developing mixture.

Glass Rods, to stir the various mixtures.

Glass Funnels, for filtering.

Blotting Paper, prepared for do.

Plate Boxes of different sizes, in which to deposit the various-sized plates when the images are fixed.

(108.) Chemicals.

Collodion, Iodized.—A four-ounce bottle will suffice for many experiments. It is advisable to have also a wide-mouthed one-

ounce phial for constant use—replenishing this from the larger bottle

Nitrate of Silver.—Six ounces of crystallised nitrate of silver will suffice for many experiments.

Glacial Acetic Acid.—A bottle holding three ounces will suffice.

Pyrogallic Acid.—Six drachms.

Hyposulphite of Soda.—Half a pound.

Ether.—Two ounces.

Nitric Acid.—One drachm.

Distilled Water.—A two-gallon bottle.

And for variations of the Collodion process:—

Sulphuric Acid.
Proto-sulphate of Iron.
Sulphate of Per-oxide of Iron.
Bromide of Potassium.
Nitrate of Baryta.

COLLODION NEGATIVES ON GLASS.

NEGATIVES ON GLASS.

(109.) Collodion is gun-cotton dissolved in ether; to which alcohol is added (155). When poured upon a plate of glass it runs freely over the surface, and the ether and alcohol evaporating, leave the collodion behind in the state of a tough transparent film, which being prepared with the salts of silver, photographic proofs can be taken upon it. In Section 155 we have given the process for preparing the iodized collodion, but it will usually be found more convenient to buy it ready prepared. By the use of this liquid we are now enabled to obtain the impression of an image by one instant's exposure to the light.

(110.) The first important operation in the collodion process is cleaning the glass plate. After all traces of impurity are removed from the surface, by washing it well in water, it is advisable to take a small quantity of diluted ammonia and Tripoli powder—

Filtered water	3 oz.
Ammonia solution	1 drachm
Tripoli powder	1 scruple

and rub it carefully over every part, including the edges. The plate must then be washed and dried with clean linen cloths, and kept free from dust until the next operation, which is—

(111.) *Coating the Plate with Collodion.*—Having arranged everything ready for use, fill a one-ounce phial with iodised collodion—and holding the glass plate by the thumb and finger of the left hand, pour out upon the glass at the part nearest the thumb a gentle stream of collodion; incline the plate dexteriously, so that by one turn of the hand the fluid may flow evenly over the plate gradually down to the lower edge, with the exception of about half an inch by which the plate is held, in this and subsequent manipulations, and then, by depressing the lower corner, the surplus collodion may be poured back into the bottle.* This operation requires some dexterity, and can be best acquired by observing a skilful person perform it; then it becomes easy. When well performed the film of collodion is perfectly smooth, free from bubbles and ripples or streaks; before it becomes dry it must be made sensitive by being submitted to the next operation.

(112.) Some precautions are necessary to be observed in the use of collodion, particularly that no pieces of dry collodion, which are apt to form round the neck and stopper of the bottle in which it is kept, fall into the fluid, as if any of them pass out on the glass plate they would produce streaks, and inevitably spoil the picture. The deposit which sometimes forms at the bottom of the reserve bottle should not be disturbed while pouring the fluid into the smaller one, as it, also, would destroy the proof.

(113.) The plate must not be immersed in the silver solution until it becomes tenacious, or *set*. The time at which this takes place varies with the season and temperature of the place where the operation is carried on. Usually the film of collodion becomes opaque all over the plate: when this change is effected, it may then be immersed in the nitrate-of-silver bath.

IMMERSION IN A BATH OF NITRATE OF SILVER.

(114.) This bath is composed in the proportions of—

Nitrate of silver	30 grains
Distilled water	1 oz.

and must be filled so as *nearly* to cover the glass plate when it is dipped in. The solution must be filtered through blotting-paper, and when not in use kept in a glass-stoppered bottle out of the light. The action of the solution-of-silver bath is some-

* This operation may be performed by daylight, but all further manipulations must be in the darkened chamber.

what irregular, owing to various causes: if the temperature of the liquid is below 60° or thereabouts, it frequently fails to form the iodide of silver. To remedy this defect the bath should be kept in a room where a fire is burning; or the bath may be immersed in warm water for a few minutes before it is required to be used.

(115.) When a fresh solution is first used in the bath, it sometimes attacks the film of collodion, dissolves it, and pieces will be found floating about in the liquid, which must be immediately filtered. A bath that has been some time in use is usually found to act better than one newly made: various remedies have been suggested, such as the addition of a few drops of nitric acid, or of iodide of potassium, allowing the fluid to re-dissolve the iodide of silver precipitated, and filter. Take the glass plate coated with collodion, lay it with its back upon a glass dipper, and at one motion plunge it into the bath, with the exception of about half an inch, by which the plate is held, in this and subsequent manipulations. Should there be any hesitation or delay, a line will certainly be formed across the collodion, which will render the plate useless. The plate should be allowed to remain in the bath about two minutes, to effect a combination between the iodine and the silver; it should then be quickly raised out of the bath, and dipped back again two or three times. This helps to get rid of a certain greasy appearance. The plate is then taken out, allowed to drain for half a minute, and then shut up in the camera-slide, and immediately taken to the camera. If, however, it is necessary to carry the prepared plate to a considerable distance, it is advantageous to cover the film of collodion with another clean plate of glass, which will prevent the moisture evaporating; it is necessary, however, to have a slide capable of holding both glasses, prepared expressly for this purpose.

EXPOSURE IN THE CAMERA.

(116.) The collodion-covered plate is now ready for exposure in the camera, which must be previously set to receive it. Any one who is unacquainted with the use of the camera should ask for directions from the person of whom he purchases it, as no written instructions can easily explain how to set the camera on the tripod, how to obtain the focus for a portrait or a view, or how to expose the sensitive surface.*

* Glass baths are sometimes made to fit into the frame of the camera in which the ground-glass screen moves. The plate being immersed, is acted upon by the light while in the solution.

(117.) Collodion is now prepared of such high degree of sensitiveness, that impressions can be made upon it, if the light is strong and the object well illuminated, in an instant; at other times, on a dull, cloudy, or rainy day, it may require from ten seconds to a minute and a half By practising daily upon the same object at the commencement of operations, we may obtain a test by which subsequent efforts can be guided. Much depends upon the quality of the collodion, the quality of the lens, and the intensity of the actinic power.

DEVELOPING.

(118.) Having allowed the collodion plate to remain exposed for the time considered sufficient, place the cap on the lens, shut up the slide, and with all expedition carry it to the operating-room, and lay the plate upon the levelling-stand, which is placed in a sink or large basin, where the image can now be developed.

(119.) The agent usually employed is the solution of pyrogallic acid, which is made as follows:—

Distilled water	3 ounces
Pyrogallic acid	9 grains
Glacial acetic acid	2 drachms;

dissolve and filter.

(120.) Sufficient of this mixture to cover the collodion plate must be taken in a small measure, and poured gently over the surface, quickly, and not all in one spot, but carried so as to be diffused as soon as possible. The fluid must be kept in motion by blowing it over the surface, to prevent the picture being stained. The plate must be watched carefully so as to stop the action as soon as the image is well developed, and a gentle stream of water poured over it to remove the decomposed liquid as quickly as possible. In cold weather it is advisable to add a few drops of nitrate of silver from the bath to the pyrogallic acid. As this process is performed the image will be seen gradually to appear upon the surface of the collodion, and we are then able to judge of our success. By holding a piece of white paper under the image it will be seen how far it is developed. When the solution becomes discolored, we may know that it has been on the plate quite long enough—perhaps too long.

(121.) Another method of developing is often used, viz. by protosulphate of iron. By this process a bath is used which will serve for a number of operations. It is prepared as follows:—

Distilled water	1 pint
Pratosulphate of iron	1 ounce
Sulphuric acid	12 minims
Acetic acid	12 "

Filter this solution, and pour sufficient into a bath, either of glass or gutta percha, to cover the plate entirely when immersed; plunge the proof in, and the image will appear in three or four seconds. If the impression is too faint, it can be strengthened by pouring over it a solution of gallic acid, containing a few drops of the nitrate of silver, which will greatly improve it.

(122.) If the proof has a grey tone all over it, the exposure in the camera has been too long; if, on the contrary, the light parts in the object remain black, it shows that the exposure has been too short.

FIXING THE PROOF.

(123.) The fixing of the proof can be effected by hyposulphite of soda, or by sulphate of per-oxide of iron.

For the first, make a saturated solution of hyposulphite of soda, and pour it carefully over the proof; it gives great transparency and vigor, but impairs the solidity of the collodion. Finish by washing with abundance of clean water, and set the plate up to dry. Should any of the hyposulphite of soda be left on the collodion, it will destroy the image.

For the second, make this solution:—

Distilled water.....1 pint
Sulphate of per-oxide of iron.....15 grains.

Having first washed the proof, pour this solution over it, and watch the development of the image; as soon as it is completed, wash the proof again under a gentle stream of water, without disturbing the collodion. Rinse with distilled water, and dry quickly before the fire, if necessary. The salt of iron will destroy the proof if allowed to remain upon it too long; it leaves an opaque yellow tint upon the shadows of the image which gives strength to a feeble impression, and positives taken from negatives thus prepared are superior to those fixed by the hyposulphite of soda.

CONVERSION OF NEGATIVES INTO POSITIVES.

(124.) A negative picture, prepared as indicated above, can be converted into a positive in various ways. That suggested by Sir John Herschel consists in smoking the glass on the collodion side. Or the proof may be backed with any black substance, such as varnish, paper, velvet, &c.

(125.) Dr. Diamond obtains the picture by the usual collopion process, and developes by proto-nitrate of iron. The negative image being developed, a mixture of hyposulphite of

soda, which has undergone partial decomposition, and pyrogallic acid, is poured over the plate, which is slightly warmed. Upon this the darkened parts are rendered brilliantly white by the formation of metallic silver. The picture, being backed up with black velvet, assumes the aspect of a fine daguerreotype, without any of the disadvantages arising from the reflection of light from the polished silver surface.

(126.) Mr. Archer obtains this result by pouring a solution of bichloride of mercury over the proof; Mr. Fry, by the combined action of pyrogallic acid and proto-nitrate of iron.

(127.) M. Marten's communication to the Academy of Sciences at Paris, details the following method of operations for producing *positives* directly on the glass plate: Make a solution of gun-cotton in ether. The gun-cotton is prepared by heating 2 parts of cotton wool with 50 parts of nitrate of potash and 100 parts of sulphuric acid. This, wher well washed and dried, is soluble in a mixture of 10 volumes of ether and 1 volume of alcohol, to which are added 15 grains of nitrate of silver, converted into the iodide by iodide of ammonium, and dissolved in 300 grains of alcohol.

(128.) The plate of glass covered in the usual way with this substance is plunged before it becomes dry into a bath composed of

Nitrate of silver	8 parts.
Nitric Acid	5 "
Distilled water	100 "

(129.) For developing it is plunged into a bath of sulphate of protoxide of iron, and carefully washed. The picture is now a *negative*, but on plunging it into a bath of the double cyanide of silver and potassium, it immediately becomes *positive*. It must next be washed and dried.

The cyanuret bath is composed of

Water	2 quarts.
Cyanuret of potassium	375 grains.
Nitrate of silver	60 "

The pictures produced in this manner possess great brilliancy.

POSITIVES ON COLLODION.

(130.) These resemble in many respects daguerreotypes, but are free from the objectional glare peculiar to the polished silver plates.

For direct positives the method of coating and exciting the sensitive surface is the same as that used for negatives. After exposure in the camera, which need not be half so much as for

negatives, the developing process is conducted with either pyrogallic acid or protosulphate of iron, with the addition to either of one or two drops of nitric acid. Various formulæ have been suggested; the following will be found as useful as any:—

Pyrogalic acid	8 grains.
Distilled water	8 ounces.
Acetic acid	1 drachm.

When mixed, add one or two drops of nitric acid, according to its strength. Mix and filter. Or,

Distilled water	1 ounce.
Protosulphate of iron	20 grains.
Acetic acid	1 drachm.
Nitric acid	1 or 2 drops.

Either of these developing solutions must be applied by gently pouring the fluid along the margin of the glass plate, and when sufficient has accumulated, by a slight movement of the hand the fluid is made to cover the whole surface of the collodion quickly and at once, because if the solution is poured on to the collodion, the action of the nitric acid is so energetic, that it would be more intense at that particular spot where the stream falls, and an unequal effect be produced.

As soon as the picture is visible, or, as soon as it *begins* to appear, the developing solution must be poured off, and the proof well washed with water, and then fixed in the usual manner by hyposulphite of soda. In drying it loses its transparency, but this can be restored by varnishing.

When the picture developes very slowly, it is due to insufficient exposure in the camera; in consequence of which the shadows, instead of being strong and even, are covered with a multitude of spots of metallic silver, which extend gradually over the whole plate. The effect is due to the de-oxydising power of the nitric acid.

When the plate has been exposed too long in the camera the developing solution acts with so much rapidity on those parts which have received most light, that it must be poured off before the half-lights are visible; in consequence of which the shadows will be very strong and pure, but the lighter parts will be vague and indistinct.

ALBUMIN ON GLASS.

(131.) This process is based on the property possessed by albumin, of becoming insoluble upon the application of heat. The application of this substance to photography on glass is due to M. Niépce de St. Victor.

(132.) Take the whites of eggs, and to every 100 grains add 1 grain of iodide of potassium, or of iodide of ammonium. Beat the whole into a froth; leave it all night to settle; decant the clear liquor, and, if necessary, strain through fine muslin.

(133.) Take a thin piece of plate glass—if ground on the surface it is preferable, because the albumin will adhere better; clean it well with distilled water, rub it dry with a piece of tissue paper, and finish with a piece of cotton wool.

(134.) Place it on a stand perfectly level; then pour over it freely the albumin, until the plate is quite covered. Take it in the hands, and so incline it that an even layer of the greatest thinness possible shall be spread over its surface, and replacing it upon the horizontal stand, put it away in a box or closet out of the reach of dust.

(135.) Before putting the albumised glass into the bath of aceto-nitrate of silver, it must be held before the fire until every trace of moisture is removed. The application of the bath is a very delicate operation, for the least hesitation in plunging the glass plate into the fluid will cause irregularities on the surface, which nothing can remove. Fill the bath about two-thirds with the following solution:—

Distilled water	5 drachms.
Nitrate of silver	24 grains.
Acetic acid	30 "

(136.) Let the albuminised plate remain in two or three minutes; then remove it; wash in distilled water, and dry in the dark.

(137.) The albumin plates thus prepared can be preserved one or two days before exposing them in the camera.

(138.) The image can be developed in the same manner as the negatives on paper, putting into the bath warm gallic acid containing not more than one-sixteenth of its volume of aceto-nitrate of silver.

(139.) We obtain much more rapidity by developing the image with a bath of saturated solution of protosulphate of iron, containing one-sixteenth of glacial acetic acid.

(140.) The time in the camera may thus be diminished three-fourths. When it is well developed it can be fixed by the same process indicated for paper (102).

(141.) Mr. Talbot's Instantaneous Process.—1. Coat a plate of glass with a mixture of albumen and water in equal proportions.

2. Dip the plate in a solution of three grains of nitrate of

silver to an ounce of a strong mixture of alcohol and water, and wash it with distilled water.

3. To a saturated solution of proto-iodide of iron add, first, an equal volume of acetic acid, and then ten volumes of alcohol. Keep the mixture for two or three days, and dip the plate into it.

4. Make a solution of seventy grains of nitrate of silver to one ounce of water. To three parts of this add two of acetic acid. This is the sensitive mixture, and the plate must be rapidly immersed in it.

5. Develope with one part of a saturated solution of proto-sulphate of iron to three parts of water, and fix with hyposulphite of soda.

By these means Mr. Talbot obtained, at the Royal Institution, the image of a printed paper made to revolve upon a wheel, and lighted up during the fraction of a second by a powerful electrical discharge.

CHEMICALS USED IN PHOTOGRAPHY

(142.) Acetic Acid. Glacial or Crystallisable.

$(C_4\ H_3\ O_3\ H\ O.)$

(Equivalent, 60=C 24 + H 4 + O 32.)

This acid is prepared by distillation from the impure pyroligneous acid of commerce. It is employed in photography, added to a solution of nitrate of silver, for the purpose of facilitating the decomposition of the iodide of potassium, as well as to assist the penetration of the solutions into the paper.

A sheet of iodized paper placed upon the solution of aceto-nitrate of silver gives rise to the following decomposition: the iodide of potassium is decomposed by the nitrate of silver under the energetic action of the acetic acid: the silver combines with the iodine on the paper, and forms an insoluble iodide of silver, which includes a little acetate of silver, and the potash of the iodide forms the nitrate of potash in solution.

Acetic acid is useful to remove the spots on the negative proofs formed by the oxide of silver.

(143.) Albumin.

This substance is readily obtained, the whites of eggs consisting wholly of that principle. When thinly spread upon a glass plate, and exposed to evaporation, it dries up to a yellow gum-like substance, in which state it may be preserved for any length

of time. In the fluid state, mixed with the sensitive iodide of silver, it is employed to make photographic pictures on—either negatives or positives; to the latter it imparts great brilliancy.

(144.) Alcohol.

This well-known liquid is of various application to photography; it is added to the etherial solution of gun-cotton (collodion), and to various sensitive preparations, for which purposes it must be free from impurity; it is sometimes contaminated with potassa and other foreign bodies: a ready test of its purity is to pour a few drops upon a piece of clean plate glass, and evaporate it over a lamp; if pure, it leaves no stain.

(145.) Ammonia Solution. (NH^3.)

(Equivalent, 17=N 14 + H 3.)

Water dissolves about 700 times its volume of ammonia (ammoniacal gas), forming the well-known spirits of hartshorn, or volatile alkali. It is a very powerful reagent, and must be employed in photography with great caution, as it forms highly explosive compounds with silver, iodine, and chlorine. Ammonia completely dissolves chloride of silver: when it is added to a solution of nitrate of silver a black precipitate falls, which is an oxide of silver; by carefully adding more ammonia, drop by drop, this powder is redissolved. The clear solution (ammonio-nitrate of silver) was first suggested by Dr. Alfred S. Taylor, as a wash for positive paper. His solution is made by dissolving 35 grains of nitrate of silver in 1 ounce of distilled water, and gradually adding strong solution of ammonia until the precipitate is just redissolved. The paper, previously prepared with the muriate of ammonia wash, is to be carefully wetted with this solution, and dried. If any of the ammonia-nitrate dries round the stopper of the bottle in which it is kept, the least friction will cause it to explode violently; it is better, therefore, to keep none prepared, but to make as much as is required for use at one time.

Iodised collodion, when kept too long, decomposes, and is no longer sensitive to light; its sensitiveness may, however, be restored by the addition of a few drops of solution of ammonia, which neutralises the acid formed, and sets the iodine free.

A weak solution of ammonia is the best "fixing" agent for those proofs which have been taken with nitrate of silver, or the ammonio-nitrate.

(146.) Bromide of Ammonium. ($N H^3 Br.$)

(Equivalent, 97=Br 80 + N 14 + H 3.)

A solution of this salt in its weight of water forms an excellent material for "fixing" the positive proofs. It is only necessary to leave them for a quarter or half-hour in a bath of this solution, and afterwards wash them in several waters, when they will be completely fixed. This quality is due to the facility with which ammonia dissolves chloride of silver.

This salt can also be used in the preparation of sensitive paper, both for negatives and positives. M. Le Gray's formula is—

Distilled water	1000 parts.
Iodide of potassium	15 "
Bromide of ammonium	4 "
Sugar of milk	40 "

(147.) Bromide of Potassium. (Br K.)

(Equivalent, 119=Br 80 + K 39.)

Bromide of potassium serves to form the bromide of silver, by decomposing the nitrate; this salt is less sensitive to light than the iodide. It is insoluble in water and alcohol, but dissolves in solution of ammonia and hyposulphite of soda. It is used by M. Le Gray and others in combination with chloride of sodium in the preparation of sensitive paper. The formula given is—

Distilled water	10 drachms.
Bromide of potassium	1 "
Chloride of sodium	1 "

Paper washed with this preparation is placed upon the aceto-nitrate of silver, as indicated in other preparations, and afterwards proceeded with in the same manner. There appear to be some difficulties attending its employment. We must content ourselves, therefore, with merely indicating its use.

(148.) Bromide of Silver. (Ag Br.)

(Equivalent, 188=Ag 108 + Br 80.)

Bromide of silver is obtained by decomposing nitrate of silver by bromide of potassium. It is one of the most sensitive preparations used in photography yet discovered. It requires to be employed in a very diluted state to effect the greatest change, and should be applied to the paper by the following means.

Wash the paper with the following solution:—

Bromide of potassium	40 grains.
Chloride of sodium	40 "
Distilled water	1 ounce.

The addition of the chloride of sodium gives great sensitiveness. When dry, float the paper upon a solution of nitrate of silver, forty grains to the ounce of water; dry the paper quickly, without scorching, and then apply another wash of the solution of nitrate of silver. The addition of a drachm of alcohol to the nitrite of silver gives a deeper black tint to the proofs.

(149.) Caustic Potassa. (K O, H O.)

(Equivalent, 56=K 39 + H 1 + O 16.)

This alkali, when added to a solution of nitrate of silver, precipitates the metal in the state of a protoxide. A small quantity dissolved in water is used to give a variety to the tones of the proofs after they have been submitted to the action of the hyposulphite of soda. It acts with great energy, and the proof must, therefore, be carefully watched, and plunged into clean water as soon as the desired effect is produced.

(150.) Chloride of Barium. (Ba Cl ^{2}H O. Muriate of Barytes.)

(Equivalent, 122=Cl 36 + Ba 68 + H 2 + O 16.)

Paper for positives prepared with this salt in the same manner as when chloride of sodium or hydro-chlorate of ammonia are employed to decompose the nitrate of silver, yield very good brown tones. When the proof has been exposed to the light a sufficient length of time, it is washed in water containing ten per cent of protosulphate of iron, which yields upon the paper a white insoluble precipitate of pleasing effect. After it has remained about five minutes in the bath, it is washed, and the "fixing" continued with hyposulphite of soda, as with the other preparations. Chloride of barium is soluble in cold water, 100 grains dissolving about 43 grains of the salt at a temperature of 60°, and 78 grains at 223°, which is the boiling point of the saturated solution.

The soluble salts of barium are poisonous.

(151.) Sesqui-Chloride of Gold. (Au^2 Cl^3.)

(Equivalent, 502=Au^2 394 + Cl^3 108.)

Chloride of Gold is prepared by dissolving one part of gold, in a state of fine powder, in three parts of nitro-hydrochloric acid (aqua regia). In combination with hyposulphite of soda, it yields the sel d'or, in a bath of which the positive proofs may be placed after they are fixed by the hyposulphite of soda; it gives to the picture a very rich, deep violet tone (106).

It is also useful to develope faint negatives, imparting to them immediately a remarkable black tint in the shadows, and at the same time gives great whiteness to the lights. It must be applied after the negatives have been fixed by the hyposulphite of soda.

(152.) Chloride of Silver. (Ag Cl.)

(Equivalent, 144—Ag 108 + Cl 36.)

This salt is rapidly acted upon by light, hence it has been extensively used in photography: it is readily obtained whenever we mix a soluble chloride with a soluble salt of silver; as, for instance, chloride of sodium with nitrate of silver. When paper is washed with a solution of the chloride of sodium, and afterwards with the nitrate of silver, the latter salt is decomposed and converted into the chloride of silver.

A coating of chloride of silver can also be obtained by the combination of hydrochloric acid, hydrochlorate of ammonia, or of strontium, and of most other chlorides with the nitrate of silver. The results are nearly the same, and the coating of chloride of silver is equally sensitive. Upon the whole the hydrochlorate of ammonia will be found preferable, because it attracts but little moisture from the air, and paper prepared with it will keep good a long time.

Chloride of silver is insoluble in water and in nitric acid. Diluted hydrochloric acid, and the alkaline cyanides and chlorides, dissolve it readily. Solutions of ammonia and of hyposulphite of soda are the most useful solvents, and they serve to "fix" the positive images.

Chloride of silver darkens rapidly under the influence of light, and is even more sensitive than the iodide of silver; but it cannot be used for negatives, for the effect of the gallic acid is to blacken it all over. Were it not for this defect, it would supply an excellent negative paper for the camera.

But, on the other hand, chloride of silver is of the greatest value for obtaining positive proofs without the aid of a reagent to develope the image. Those portions acted upon by light are rapidly brought to a state of sub-oxide, and to the metallic state, if the exposure is prolonged. These oxides and metallic silver being black, we have at once all the qualities desired in this sort of paper; therefore it would be useless to employ gallic acid to produce the black.

To arrest the action of light, it is sufficient to remove the soluble salts from the surface of the paper.

(153.) Chloride of Sodium. (Na Cl, Muriate of Soda.)

(Equivalent=60 Cl 37 + Na 23.)

Chloride of sodium is familiarly known as common culinary salt. It is obtained in greater purity by saturating carbonate of soda with hydrochloric acid. In photography it is used to prepare the positive paper, upon which a coating of chloride of silver is produced by decomposing the aceto-nitrate of silver with a chloride.

Mixed with a small quantity of iodide and of bromide of potassium, the chloride of sodium supplies us with an excellent preliminary wash for the negative paper.

(154.) Chloride of Strontium. (Cr Cl, ^{6}H O.)

(Equivalent, 134=Sr 44 + Cl 36 + H6 + O 48.)

The use of this salt can only be allowed when no other chloride is at hand to decompose the nitrate of silver, as it attracts much moisture from the air. 100 grains of cold water dissolve 50 grains, and boiling water much more, of this salt.

(155.) Collodion.

Collodion is gun-cotton dissolved in ether; its solubility depends upon the mode of preparing the gun-cotton. Many formulæ have been given for the purpose; that which is most readily soluble is obtained by soaking clean cotton wool in a saturated solution of nitrate of potash. After thoroughly soaking for some time, pressing it occasionally with a glass rod, remove the excess of nitrate of potash, and pour over the cotton a sufficient quantity of sulphuric acid, with which a small quantity of nitric acid has been mixed; this must be done in the open air, or under a chimney, to carry off the noxious fumes. In a about a minute or two remove the cotton and place it on a

funnel, and pour over it a stream of clean water, until the washings cease to turn litmus paper red. It is then squeezed by the hand to express the water, left to drain, and dried spontaneously in the air of an apartment. As it is now the well-known highly explosive compound, gun-cotton, we need scarcely remark that great caution must be exercised in the use of it.

When dry it is dissolved in sulphuric ether, as follows:—

Sulphuric ether	18 fluid ounces.
Alcohol	6 drachms.
Gun-cotton	30 grains.
Solution of ammonia	5 drops.

Make this solution in a flask, and by agitating the mixture the gun-cotton quickly dissolves. Then add five grains of iodide of ammonium: when dissolved, filter the whole through fine muslin, in a glass filter, covered to prevent evaporation. After standing a day or so, it is fit for use.

As some portion of the ether evaporates every time the stopper is removed from the bottle in which this solution is kept, it is preferable to have a small bottle containing only as much as is required to take three or four pictures on, and replenish it from the larger stock-bottle as required. If it becomes too thick it can be diluted with more ether.

There are other methods of iodizing the collodion; the following is Mr. Archer's method:—Make a saturated solution of iodide of potassium in alcohol, say one ounce, and add to it as much iodide of silver as it will dissolve. Or, to one ounce of alcohol add an excess both of iodide of potassium and iodide of silver. After a day or two, and with repeated shaking at intervals to facilitate the operation, a saturated solution of the two salts will be obtained; and if this is filtered off into another bottle it will be always ready for use. The first bottle can be kept as a stock-bottle, to obtain a still further supply by replenishing it with alcohol, and adding now and then small additional quantities of the two salts. The iodide of silver can be readily obtained by precipitation.

(156.) Cyanide of Potassium. (K Cy.)

(Equivalent, 65=C 12 + N 14 + K 39.)

This salt is a compound of prussic acid with potassium, and a very deadly poison. It is used in photography; added to nitrate of silver, it yields cyanide of silver, which is very sensitive to the action of light; but when added to the iodide and the fluoride of potassium, it forms a triple salt of great sensitiveness,

Cyanide of silver is insoluble in water, and in diluted nitric acid. It is decomposed by hydrochloric acid, and changed into chloride of silver. Solution of ammonia, the alkaline cyanides, and especially hyposulphite of soda, dissolve it.

The cyanide of potassium dissolves the iodide, chloride, and bromide of silver; it also dissolves the protoxides and suboxides of this metal when they are precipitated by gallic acid. A solution of the salt is useful, with the aid of a brush, to remove the black spots which injure the proofs; only it must be applied with great caution, and the proof immersed in water immediately after its application, else it may destroy it entirely.

The cyanide of potassium is useful for removing the stains of nitrate of silver from the hands. Great caution must be observed in using it that the skin is not wounded, else the poison would be quickly absorbed, and fatal consequences ensue.

(157.) Ether.

A colorless, volatile fragrant liquid, very combustible, slightly soluble in water, and mixable with alcohol in all proportions. In photography its chief use is as a solvent for gun-cotton to produce Collodion, *q. v.*

(158.) Fluoride of Ammonium. (Az H 3, Fl.)

(Equivalent, 36=Fl 19 + Az 14 + H 3.)

This salt, added to the iodide of potassium, imparts a great increase of sensitiveness; but it does not appear to be so useful as the fluoride of potassium.

(159.) Fluoride of Potassium. (K Fl.)

(Equivalent, 58=Fl 19 + K 39.)

Fluoride of potassium adds to the sensitiveness of the prepared paper when mixed with the iodide of potassium. The process in which the fluorides are employed is termed the Fluorotype.

(160.) Gallic Acid. (C_7 H^3 O_5, ^2H O.)

(Equivalent, 103=C 42 + H 5 + O 56.)

This acid is obtained from nut-galls. It is employed in photography as a developing agent for negative proofs. It gives to them the black tints, by its combination with the salts of silver, which have lost their oxygen in the action of light.

All the salts of silver, generally, which are in a state of suboxide, or near the metallic state, are precipitated of a black-brown color by this acid: consequently we can employ it for developing the proofs made by the iodide, bromide, fluoride, or cyanide, as well as those made by the iodide of silver.

Some practitioners recommend that this salt be used in a concentrated state, as a rapid developing agent. M. Le Gray uses a weak solution, fifteen to thirty grains to a quart of distilled water, by which means there is much less danger of spotting the proofs: it takes more time to develop them, which is compensated for by their great beauty.

Gallic acid is but slightly soluble in cold water, 1 grain of the acid requiring 100 grains of water for its solution; but 3 grains of boiling water will dissolve 1 grain of the acid. The solution is gradually decomposed by keeping.

When the proof is almost entirely developed, if we add a little of the aceto-nitrate of silver the shadows become immediately more intense; but it must be carefully watched, else too great an intensity will take place, from a rapid precipitation of gallate of silver.

(161.) Hydrochlorate of Ammonia. (Az H 3, H Cl, Muriate of Ammonia, Sal Ammoniac.)

(Equivalent, 54=Az 14 + H 4 + Cl 36.)

Hydrochlorate of ammonia is very useful in the preparation of positive paper; it decomposes nitrate of silver, forming the chloride of that metal, and is a better preparation than chloride of sodium, since it attracts less moisture from the air. 100 parts of cold water dissolve 36 parts of the salt, and boiling water its own weight; and it is also very soluble in alcohol.

(162.) Hydrochloric Acid. (Cl H, Muriatic Acid.

(Equivalent, 37=Cl 36 + H 1.)

This acid is prepared by decomposing common salt with sulphuric acid. Diluted with water it has been employed to give a rich brown tone to the proofs after they have passed through the bath of hyposulphite of soda, and been washed in water. Mixed with nitric acid it forms the aqua regia in which gold is soluble, and from which the chloride of gold, or sel d'or, is obtained.

(163.) Hypochlorite of Potassa. (K O, Cl O.)

(Equivalent, 91=K 39 + O 16 + Cl 36.)

This salt has bleaching properties, although inferior to chloride of lime. Dissolved in its weight of water, the solution is applied to spots or stains on the prepared paper. It also fixes the positive proofs, and yields very agreeable tones. The hypochlorite of lime (bleaching powder) produces the same effect.

(164.) Hyposulphite of Soda. ($Na\ O, S^2\ O^2 + 5\ H\ O$.)

(Equivalent, 124. Na 23 + S 32 + O 64 + H 5.)

This salt is very soluble in water at all temperatures. It is of great service in photography, for "fixing" the proofs, which it accomplishes by dissolving the salts of silver, such as the chloride, iodide, &c., which are insoluble in water, and so removing them from the proof, and thereby preventing any further chemical change in the impression. The solution of hyposulphite of soda, after it retains some of the salts of silver in solution, is more useful for the fixing process, as it gives better black tones than when first employed. It is the best fixing material yet discovered, both for positives and negatives; and by careful manipulation almost every variety of tone can be given to the proofs. With faint positive proofs it is best to soak them for a few hours in a bath of clean water, before submitting them to the action of the hyposulphite of soda; by which means the soluble salts of silver are removed without effecting those parts acted upon by the light, which constitute the blacks. Thus we abridge the time necessary for the action of the hyposulphite, and the fixed image is found to be more vigorous than if it had been placed at once in the hyposulphite af soda.

(165.) Iodide of Ammonium. (Az. H 3, H Io.)
(Hydriodate of Ammonia.)

(Equivalent, 145=H Io 128 + N 14 + H 3.)

The hydriodate of ammonia is a compound very easily decomposed: it must be kept suspended in a bottle containing a small quantity of carbonate of ammonia.

Sensitive papers may be prepared by washing them with a solution of this substance previous to placing them upon the aceto-nitrate of silver; an impression is received with great rapidity, which is developed with facility by gallic acid, to which a little acetate of ammonia has been added.

Paper prepared with the hydriodate of ammonia will not keep long; it loses its sensitiveness by the continuous evaporation of the ammonia.

(166.) Iodide of Potassium. (K Io.) (Hydriodate of Potash.)

(Equivalent, 166=K 39 + Io 127.)

Iodide of potassium is one of the principal chemical agents in photography. It serves to form the iodide of silver, which is the sensitive salt upon which light acts with the greatest energy. This iodide of silver is insoluble in water, but soluble in hyposulphite of soda, which is used for "fixing" the negative proofs.

(167 Iodide of Silver. (Ag I.)

(Equivalent, 235=Ag 108 + I 127.)

Iodide of silver is obtained by adding iodide of potassium to a solution of nitrate of silver; decomposition ensues, the nitric acid leaves the silver and unites with the potash, while the liberated iodine combines with the silver, and falls as a yellow precipitate, which must be well washed in distilled water, being insoluble therein, to remove the nitrate of potash, and then dissolved in a saturated solution of iodide of potassium. This mixture is to be added to the collodion in small quantities at a time, and agitated until dissolved.

Formula for the preparation of iodide of silver:

Distilled water	1 ounce.
Nitrate of silver	30 grains.

Add to it as much of an aqueus solution of iodide of potassium as will precipitate the whole of the nitrate of silver as an iodide. When this precipitated iodide of silver has settled, the fluid must be decanted, and fresh water added several times, to wash out all the nitrate of potash. Drain off all the water, and when dry cover the iodide with sufficient alcohol to keep it moist. This iodide of silver is soluble in iodide of potassium: the quantity required to iodize the collodion cannot be stated with certainty; about ten or twelve drops to the ounce is usually added.

(168.) Nitrate of Baryta. (Ba O, N O^5.)

(Equivalent, 130·5=Ba 68·5 + N 14 + O 48.)

This salt is prepared by dissolving the native carbonate of

baryta in muriatic acid. It is used in photography to obtain the proto-nitrate of iron, by decomposing with it a solution of proto-sulphate of iron.

(169.) NITRATE OF PROTOXIDE OF IRON. ($Fe\ O, N\ O_5$.)

(Equivalent, 90 = Fe 28 + N 14 + O 48.)

A solution of this salt is employed for developing collodion proofs as negatives, either alone or in combination with pyrogallic acid. It is best prepared by decomposing a solution of nitrate of baryta by a solution of the sulphate of protoxide of iron in the following manner:—Make a solution in three ounces of hot water of 300 grains of nitrate of baryta; when dissolved, add 320 grains of sulphate of protoxide of iron, in crystals, and stir the mixture with a glass rod until all are dissolved. After a while the sulphate of barytes formed by the decomposition falls to the bottom of the vessel, and the supernatant liquid, the proto-nitrate of iron, may be decanted, and kept in a well-stoppered bottle for use. This solution is very liable to decomposition; but so long as it retains an emerald green color it is fit for use, but if it turns red it should be thrown away.

(170.) NITRATE OF SILVER. ($Ag\ O, N\ O_5$.)

(Equivalent, 170=Ag 108 + N 14 + O 48.)

Nitrate of silver is a very important ingredient in photography; it is a compound of nitric acid with the metal silver in its highest state of oxydation. It is decomposed by iodide of potassium, by which iodide of silver is obtained. The best nitrate of silver is in thin colorless crystalline plates (the *fused* is generally adulterated), which are soluble in an equal weight of cold water. Exposed to light this salt blackens, especially if any organic matter is present; advantage is taken of this property to prepare the sensitive solutions which are spread upon the paper. and other media employed in obtaining photographic pictures. It is readily decomposed by chlorides, bromides, fluorides, cyanides, &c., producing salts of exquisite sensibility; and if these, or some of them, are added to the iodide of potassium, in the first preparation of the paper, when they are submitted to the contact of the nitrate of silver, compounds are formed, apparently intermediate in their atomic constitution between the protoxide and the suboxide of silver. As soon as the light strikes these preparations in this condition, they pass from the state intermediate between the protoxide and suboxide to the

metallic state, the silver is *reduced*, and is precipitated in a dark-colored form by gallic, or pyrogallic acid, in various degrees of strength, according to the extent of the reduction. The chief object and aim in the future of photography is in the direction of the developing agents. We have found substances which require but an instantaneous exposure to the action of light to effect that change, which once set up is continued and completed by suitable developing agencies.

(171.) Nitrate of Zinc. (Zn O. Az O^5.)

(Equivalent, 94=Zn 32 + Az 14 + O 48.)

Nitrate of zinc is obtained by dissolving granulated zinc in diluted nitric acid. It has been added by some photographers to the aceto-nitrate of silver, under the impression that it augments the sensibility of the preparation, and preserves the whites in the proofs by precipitating upon the surface of the paper a coating of the white oxide of zinc, M. Le Gray uses it to give body to thin paper, by washing it with a solution of 6 parts of nitrate of zinc in 100 parts of water, drying it, and then immersing it in the bath of iodide of potassium. The precipitate, falling upon the surface of the paper, closes the pores, and it is insoluble in water.

(172.) Nitric Acid. (N, O_5.)

(Equivalent, 54=Nitrogen, 14 + Oxygen, 40.)

This acid is obtained by distilling a mixture of equal parts, by weight, of nitrate of potash and sulphuric acid. It is very abundant in commerce, and is useful in photography to form the nitrate of silver; and in combination with muriatic acid (aqua regia) to yield the chloride of gold added to the sulphate of the protoxide of iron, it converts it into the sulphate of the peroxide.

It is also employed to darken the tone of the shadows of the positive proofs after they have been submitted to the action of the hyposulphite of soda. Its action is similar to that of the muriatic acid used for the same purpose.

As it possesses great solvent powers, it is very useful for removing the deposit left on the gutta percha or porcelain dishes, &c.; but the greatest care must be taken that no free acid appears in any of the preparations used in photography; for however useful in its combinations with silver, &c. alone, it has a most destructive influence by its deoxydising qualities, neutralising the effects produced by the agency of light.

(173.) Proto-Cloride of Mercury. (Hg Cl.)

(Equivalent, 136=Hg 100 + Cl 36.)

The proto-chloride of mercury, commonly called the *bi*-chloride, or corrosive sublimate, is employed in photography for converting collodion negatives into positives.

Saturate muriatic acid with proto-chloride of mercury; add one part of the solution to six parts of water; after the proof is fixed and washed, pour a small quantity over it from one corner, and allow it to run evenly over the proof. A peculiar whitening appears, and a singularly delicate picture is produced. After being washed and dried, it can be varnished and kept as a positive; but, what is most singular, even after this bleaching, it can be reconverted into a negative of much greater strength than it was originally, by washing it with a weak solution of hyposulphite of soda, or of ammonia: the white picture vanishes, and a black negative reappears.

When the proto-chloride of mercury is first applied to the negative it deepens its shades, and greatly strengthens the face of the proof, and the process of change can be stopped at this point by simply immersing the plate in water. The solution of the proto-chloride, when this result is desired, should be used much more diluted with water than when it is required for converting negatives into positives. This conversion can be repeated several times, often to the great improvement of the proof.

(174.) Pyrogallic Acid. (C_6 H_3 O_3.)

(Equivalent, 63=C 36 + H 3 + O 24.)

This powerful developing agent is prepared, according to the formula of Dr. Stenhouse, in the following manner:—

Make a strong aqueous infusion of powdered nut-galls; pour it off from the undissolved residue, and carefully evaporate to dryness by a gentle heat: towards the conclusion of the process the extract is very liable to burn; this is best prevented by continually stirring with a glass or porcelain spatula. Next, procure a flat-bottomed iron pan, about ten inches in diameter, and five inches deep. Make a hat of cartridge-paper about seven inches high, to slip over and accurately fit the top of the iron pan. Strew the bottom of the pan with the gall extract to the depth of three-quarters of an inch; over the top stretch and tie a piece of bibulous paper, pierced with numerous pin-

holes; over this place the hat, and tie it also tightly round the top of the pan.

The whole apparatus is now to be placed in a sand-bath, and heat cautiously applied. It is convenient to place a thermometer in the sand-bath as near the iron pan as possible. The heat is to be continued about an hour, and to be kept as near 420° F. as possible: on no account to exceed 450°. The vapor of the acid condenses in the hat, and the crystals are prevented from falling back into the pan by the bibulous paper diaphragm. When it is supposed that the whole of the acid is sublimed, the strings are to be untied, and the hat and diaphragm cautiously taken off together; the crystals will be found in considerable quantity, and may be removed into a stoppered bottle: they should be very brilliant, and perfectly white; if there is any yellow tinge, the heat has been too great.

Pyrogallic acid dissolves readily in water; the solution is speedily decomposed, becoming black.

"SIZING" MATERIALS.

(175.) STARCH, ALBUMIN, GALATINE, WAX.

Starch dissolved in boiling water forms a "size," which is afterwards insoluble in cold water; the best for the purposes of photography is obtained from rice.

Starch has a great affinity for iodine, and causes it to abandon most of the bases with which it is united. The iodine colors starch a deep blue, which serves to aid us in recognising its presence in a liquid. Wax has also a similar affinity for iodine.

Starch is capable of being converted into a gummy substance called dextrine. A mixture of 15 parts of starch, 60 parts water, and 6 parts sulphuric acid, may be kept boiling for about four hours; the liquid neutralised with chalk, filtered, and rapidly evaporated to a small bulk. This substance is dextrine, and is sold under the name of British gum. It is a useful substitute for glue, as it is soluble in cold water.

(176.) A warm solution of gelatine, applied upon paper at the same time with the iodide and other salts, leaves a size which does not dissolve in cold water.

(177.) Albumin also forms an excellent size, from its property of becoming insoluble in acids and in alcohol by the application of heat (about 150°)

(178.) Collodion applied to paper answers the purpose of a size; but its chief application is to glass, when iodized, to obtain instantaneous impressions.

This substance has a remarkable effect in forming the blacks in the proofs, at the same time it is a good size.

(179.) Wax becomes permeable to liquids after it has remained in a bath containing alkaline salts; it forms also an excellent size, and does not exclude the use of others.

(180.) Alum.—English paper soaked for a few minutes in a strong solution of alum, and afterwards washed in clean water, is in an improved condition for receiving the solution of salts of silver for positives.

(181.) Sulphate of Protoxide of Iron. ($Fe\ O, S\ O^3$.)

(Equivalent, 76=Fe 28 + 4 O 32 + S 16.)

This substance is well known under the names of green copperas or green vitriol. It is employed in photography as a means of converting a collodion negative into a positive (124).

DEFINITION OF THE TECHNICAL TERMS EMPLOYED IN PHOTOGRAPHY.

(182.) *Concentration.*—This is a thickening process produced by the action of heat upon solutions, by which the liquid is evaporated, and the solution becomes more dense, or nearer to the solid state.

Crystallisation.—Certain bodies, such as salts, in passing from a state of solution to the solid, assume regular forms, which are called crystals. By redissolving these crysals, and again crystallising them, we obtain the crystallised substance in a state of greater purity.

Decantation.—Solutions, when allowed to stand undisturbed for a certain time, frequently deposit a sediment, from which it is desirable to remove the clear supernatant liquid; this operation, when accomplished by a siphon or pipette, or by gently inclining the vessel so as not to disturb the sediment, is termed Decantation. It sometimes serves the purpose of Filtration.

Decomposition.—This action takes place when two compound solutions are mixed, and the constituents change places; for instance, when we add sulphuric acid to chloride of barium, the acid seizes upon the barium forming sulphate of barytes, and the chloride is displaced or set free; but when we add nitrate of silver to chloride of barium, *double* decomposition ensues; the chlorine goes to the silver, giving rise to chloride of silver, while the nitric acid combines with the barium, forming nitrate of barytes.

Diaphragm.—Discs pierced in their centre with round holes

of different dimensions, and placed in front of the lenses of the camera, to exclude the excess of light, and to modify the clearness of the image in the focus. They also serve to correct the spherical aberration.

Evaporation.—Certain volatile substances, such as ether, alcohol, &c., entirely disappear, or evaporate, upon exposure to the atmosphere; so also does water, and other fluids, but more slowly: when these fluids contain solid bodies in solution, they become, by evaporation, concentrated, and finally restore to the solid form the solid held in solution, which is left behind by the removal of the fluid in the state of vapor.

Proofs, Positives and Negatives.—The impressions produced by the action of light upon prepared sensitive media are of two kinds, Negatives and Positives. The Negatives are those in which the lights and shadows are reversed, such as are obtained in the camera on paper, albumen, &c. The *Negatives* obtained upon collodion can be converted into *Positives* by varying the developing process.

Positives are those obtained by super-imposing a Negative upon paper prepared for the purpose; producing a reverse effect by the passage of light through the non-darkened portions of the Negative, and yielding a picture resembling, in its light and shade, an engraving; and of various tints, from a light bistre, through various gradations of violet and black. Positives can also be produced at once by employing the proper developing agent.

Nascent State.—To act upon a substance in its nascent state, is to use it at the moment of its formation, and before the air, or other foreign body, has had time to modify it.

Precipitation.—A substance held in solution by a liquid is *precipitated* by adding to the liquid another substance for which it has a greater affinity, through which it leaves the first substance and *precipitates* it.

Rectification—Is the operation by which a substance is brought to a greater state of purity; in fluids this is sometimes accomplished by distillation; in certain solids by recrystallisation.

Reduction.—Is the operation by which the oxides of metals pass into the metallic state.

Solution.—In the dissolving of a solid body in a liquid, such as water, alcohol, &c. Bodies are melted by the action of heat, or by their chemical action upon each other; but these are not *solutions*, which require a *solvent*.

Saturation.—Saturated Solution.—Generally speaking, most liquids will only dissolve a certain given quantity of a solid body

submitted to their action, varying, however, with the temperature at which the solution is made. Thus, 100 ounces of water at 60° will dissolve only 36 ounces of muriate of ammonia; if the water is at the boiling point it will dissolve its own weight of the salt; but the excess is deposited again as the water cools down to 60°. It requires 143 ounces of iodide of potassium to saturate 100 ounces of water at 65°. Common salt is equally soluble in water at all temperatures.

A FEW PRACTICAL HINTS ON THE COLLODION PROCESS.

(183.) Ascertain that the frames are accurately adjusted to the focus of the lens. A difference exists between the apparent and the chemical foci of some lenses, which should be adjusted by the maker of the camera, or a clear picture will never be obtained. If an optician is not near who can test this difference, the error that exists may be discovered by trying upon the same object three or four times; and at each trial, after having focused the object upon the ground-glass, turning the rack of the lens more or less backwards or forwards as may be required. We can thus note where the sharpest impression is obtained.

Be very careful that the glass plates are *perfectly* clean; more failures arise from want of care in this respect than from any other causes.

Keep the nitrate-of-silver bath covered up when not in use. The slightest impurity in it may spoil a good picture.

Remember that nitrate of silver blackens almost everything it touches. The fingers will soon exhibit stains that no washing can remove, but they will wear off in a few days. If gloves are used when operating with the plate with the nitrate on, and taken off during all other manipulations, no harm will result, and the fingers will be saved; but if gloves are used constantly, and any of the hyposulphite or the pyrogallic acid remain on them, it would be apt to spoil the next plate prepared. Cyanide of potassium will clean the hands at any time, but is a deadly poison, and even the fumes of it are nauseous. It is better not to have recourse to it; a substance called cyanogen soap has lately been introduced for cleaning the hands from these stains.

Be careful, in weighing or measuring, that the scales or measures are quite clean. After each operation they must be carefully wiped.

Be sure that no light, except the subdued light of the oper-

ating-room, falls upon the plate from the time it is taken from the nitrate bath until after it is developed. Some operators even cover up the slide in a little bag while removing it from the room to the camera.

It is best to expose the plate in the camera as soon as possible after it leaves the bath; but it may sometimes be necessary to carry it a short distance, which must be done as quickly as possible, so as not to allow time for the plate to dry; and upon returning, plunge it again, but for a fraction of a second only, into the nitrate-of-silver bath.

If the bath appears impure, drop two or three minims of nitric acid into it, and after a few minutes pour off all the clear liquid into a clean vessel; then rinse out the bath with distilled water, and pour the clear liquid back again.

Common cistern or river water is full of impurities, which would decompose many salts if dissolved in it. If distilled water cannot be got, clean ice melted produces very pure water; and boiled rain-water, filtered may do as a substitute.

The developing solution should always be filtered, and placed out of the reach of splashes. It will remain useful for many days.

(184.) Weights and Measures.

Apothecaries' Weight

1 grain.				
20 =	1 scruple.			
60 =	3 =	1 drachm.		
480 =	24 =	8 =	1 ounce.	
5760 =	288 =	96 =	12 =	1 pound.

Fluid Measure.

						Grains.	
				1 minim	=	0·91	
			60 =	1 fluid drachm	=	54·7	*Avoird.*
		480 =	8 =	1 fluid ounce	=	437·5	= 1 oz.
	9,600 =	160 =	20 =	1 pint	=	8,750	= 1·25 lb.
76,800 =	1280 =	160 =	8 =	1 gal'n	=	70,000	= 10 lbs.

One Pound Avoirdupois	contains	7,000	grains.
One Pound Troy	"	5,760	"
One Imperial Gallon of water	"	70,000	"
One Imperial Pint of Water	"	20 oz. or 8,750	"
One Cubic Inch of Water	"	252·4	"
One Ounce Avoirdupois	"	437·5	"
One Ounce Troy	"	480	"
One *Gramme*	"	15·4	"
One *Decigramme*	"	1·5	"
One *Litre* of Distilled Water	"	15,406.3	"

*** The grain is the unit of weight; but as three standards of weight are employed, much uncertainty and confusion often arise in the mind of the photographer as to which ounce or drachm is meant. The apothecaries' weight is generally understood to be the one employed; but it would save much trouble if the formula for the various preparations were always given in grains.

APPENDIX.

PROCESSES ON PAPER.

1.—Iodising the Paper.*—Mr. Talbot's Process.

Take a sheet of the best writing-paper, having a smooth surface, and a close and even texture; the water-mark, if any, should be cut off, lest it should injure the appearance of the picture. Dissolve 100 grains of crystallised nitrate of silver in six ounces of distilled water. Wash the paper with this solution with a soft brush on one side, and put a mark on that side whereby to know it again. Dry the paper cautiously at a distance from the fire, or let it dry spontaneously in a dark room. When dry, or nearly so, dip it into a solution of iodide of potassium, containing 500 grains of that salt dissolved in one pint of water, and let it stay two or three minutes in the solution. Then dip the paper into a vessel of water, dry it lightly with blotting-paper, and finish drying it at a fire, which will not injure it, even if held pretty near; or else it may be left to dry spontaneously. All this is best done in the evening by candle-light: the paper, so far prepared, is called *iodised paper*, because it has a uniform pale yellow coating of iodide of silver. It is scarcely sensitive to light, but nevertheless it ought to be kept in a portfolio, or drawer, until wanted for use.

The calotype paper is rendered more sensitive by placing a warm iron behind it in the camera whilst the light is acting upon it.

Io-gallic paper is prepared by washing a sheet of iodised paper with gallic acid. In this state it will keep in a portfolio, and is rendered sensitive to light by washing it over with a solution of nitrate of silver.

Iodised paper is washed with a mixture of twenty-six parts of a saturated solution of gallic acid to one part of the solution of nitrate of silver ordinarily used. It can then be dried without fear of spoiling, may be kept a little time, and used without further preparation.

MR. H. CUNDELL'S PROCESS.

Much depends upon the paper selected for the purpose; it must be of a compact and uniform texture, smooth and transparent, and not less than medium thickness. The best I have met with is a fine satin post paper made by "R. Turner, Chaf-

* It has since been found a better method to iodise the paper previous to applying the nitrate of silver.

ford Mill." Having selected a half sheet without flaw or water-mark, and free from, even the minutest black specks, the object is to spread over its surface a perfectly uniform coating of the iodide of silver, by the mutual decomposition of two salts, nitrate of silver and iodide of potassium. There is a considerable latitude in the degree of dilution in which these salts may be used, and also in the manner and order of their application; but as the thickness and regularity of coating depend upon the solution of nitrate of silver, and upon the manner in which it is applied, I think it ought, by all means, to be applied first, before the surface of the paper is disturbed. I use a solution of the strength of seventeen grains to the ounce of distilled water.

The paper may be pinned by its two upper corners to a clean dry board a little larger than itself; and holding this nearly upright in the left hand, and commencing at the top, apply a wash of the nitrate of silver *thoroughly*, *evenly* and *smoothly*, with a large soft brush, taking care that every part of the surface be thoroughly wetted, and that nothing remain unabsorbed in the nature of free or running solution.

Let the paper now hang loose from the board into the air to dry, and by using several boards time will be saved.

The nitrate of silver spread upon the paper is now to be saturated with iodine, by bringing it in contact with a solution of the iodide of potassium; the iodine goes to the silver, and the nitric acid to the potash.

Take a solution of the iodide of potassium of the strength of 400 grains to the pint of water, to which it is an improvement to add 100 grains of common salt. Pour the solution into a shallow, flat-bottomed dish, sufficiently large to admit the paper, and let the bottom of the vessel be covered to the depth of one-eighth of an inch. The prepared side of the paper, having been previously marked, is to be brought in contact with the surface of the solution; and as it is desirable to keep the other side clean and dry, it will be found convenient, before putting in the iodine, to fold upwards a narrow margin along the two opposite edges. Holding by the upturned margin, the paper is to be gently drawn along the surface of the liquid until its lower face be thoroughly wetted in every part; it will become plastic, and in that state may be suffered to repose for a few moments in contact with the liquid: it ought not, however, to be exposed in the iodine dish for more than a minute altogether, as the new compound, just formed upon the paper, upon further exposure, would be gradually re-dissolved. The paper is, therefore, to be removed; and after dripping, it may be placed on any clean sur-

face with the wet side uppermost, until about half dry, by which time the iodine solution will have thoroughly penetrated the paper, and have found out and saturated every particle of the silver; which it is quite indispensable it should do, as the smallest particle of undecomposed nitrate of silver would become a black stain in the subsequent part of the process.

The paper is now covered with a coating of the iodide of silver; but it is also covered, and indeed saturated, with saltpetre and the iodide of potassium, both of which it is indispensable should be completely removed. To effect the removal of these salts, it is by no means sufficient to dip the paper in water; neither is it a good plan to wash the paper with any considerable motion, as the iodide of silver, having but little adhesion to it, is apt to be washed off. But the margin of the paper, being still upturned, and the unprepared side of it kept dry, it will be found that by setting it afloat on a dish of clean water, and allowing it to remain for five or ten minutes, drawing it gently, now and then, along the surface to assist in removing the soluble salts; these will separate by their own gravity, and (the iodide of silver being insoluble in water) nothing will remain upon the paper but a beautifully perfect coating of the kind required.

The paper is now to be dried; but while wet, do not, on any account, touch or disturb the prepared surface with blotting-paper or with anything else. Let it merely be suspended in the air, and in the absence of a better expedient, it may be pinned across a string by one of its corners: when dry, it may be smoothed by pressure. It is now "iodised" and ready for use, and in this state will keep any length of time if protected from the light.

MR. BINGHAM'S METHOD.

Apply to the paper a solution of nitrate of silver containing 100 grains of that salt to one ounce distilled water. When nearly, but not quite dry, dip it into a solution of iodide of potassium of the strength of 25 grains of that salt to 1 ounce of distilled water, drain it, wash it, and then allow it to dry. Now brush it over with aceto-nitrate of silver, made by dissolving 50 grains of nitrate of silver in 1 ounce distilled water, to which is added one-sixth its volume of acetic acid. Dry it with bibulous paper, and it is now ready for receiving the image.

MR. CHANNING'S METHOD.

The paper should be first washed over with 60 grains of nitrate of silver dissolved in 1 ounce distilled water, and when

dry, with a solution of 10 grains of iodide of potassium in 1 ounce of water; it is then to be washed in water, and dried between folds of blotting-paper: the sensibility of the paper is said, and correctly, to be much improved by combining a little chloride of sodium with the iodide of potassium, 5 grains of the latter salt, and rather less than this of the former, in an ounce of water, may be employed advantageously.

To use this paper where time is an object, it is necessary to wash it immediately before it is placed in the camera, with a weak solution of nitrate of silver, to which a drop or two only of gallic acid has been added. The picture is subsequently developed by the gallo-nitrate of silver.

MR. JORDAN'S METHOD.

Iodide of silver is precipitated from the solution of the nitrate by iodide of potassium, and this precipitate, being lightly washed, is redissolved in a strong solution of the latter salt. The solution is applied to the paper, and the paper allowed to dry: after this it is placed, face downwards, upon some clean water; the iodide of potassium is removed by this, and a pure iodide of silver left upon the paper.

M. MARTENS' METHOD.

M. Martens uses spirits of wine after the picture has been developed, to improve its tone.

For the negative picture:

First,—

Iodide of potassium	½ oz.
Distilled water	10 "
Concentrated solution of cyanide of potassium	7 drops.

Second,—

Nitrate of silver	7 drachms.
Distilled water	10 oz.
Strong acetic acid	2 drachms.

The iodine solution should be applied first, and dried; then the argentine solution, and dried rapidly: the advantages of this are, that the iodide of silver is left on the surface of the paper ready for the influence of the slightest chemical action.

Third,—

A concentrated solution of gallic acid.

Fourth,—

Good spirits of wine.

Fifth,—

Hyposulphite of soda	1 oz.
Distilled water	10 "

For the positive pictures:

First,—

Chloride of sodium	168 grains.
Distilled water	10 oz.

Second,—

Nitrate of silver	1 oz.
Distilled water	10 "

Third,—

Hyposulphite of soda	1 oz.
Distilled water	10 "

Nitrate of silver 30 grains, dissolved in ½ oz. of water, to be poured into the solution in a small stream, while it is constantly stirred with a glass rod.

M. LE GRAY'S PROCESS.

For negatives:

First operation,—

Isinglass, 300 grains, dissolved in $1\frac{3}{4}$ pint of distilled water by means of a water-bath.

Take one half of this preparation while warm, and add to it as under,—

Iodide of potassium	200 grains.
Bromide of potassium	60 "
Chloride of sodium	34 "

Let these salts be well dissolved, then filter the solution through a piece of linen; put it, still warm, in a large dish, and plunge in your paper completely, leaf by leaf, one on the other, taking care to prevent the air-bubbles from adhering to the paper.

Put about twenty leaves at a time into the dish, then turn the whole, those at the top to the bottom; then take them out one by one, and hang them by one corner with a pin bent like the letter S, to dry spontaneously. When hung up, attach to the opposite corner a piece of bibulous paper, which will facilitate the drying.

When the paper is dry, cut it to the size required, and preserve it in a folio for use. This paper may be made in the daytime, as it is not sensitive to light.

Second operation,—

Prepare, by the light of a taper, the following solution in a stoppered bottle:

Nitrate of silver	250 grains.
Distilled water	6 fl. ounces.

When the nitrate is dissolved, add,

Crystallisable acetic acid	1 ounce.

Cover the bottle with black paper, and keep it from the light.

When you wish to operate, pour the solution upon a porcelain or glass slab, having a border of glass or wax; take a sheet of the iodised paper by the two corners, holding them perpendicularly, and gently lower the middle of the paper upon the centre of the slab, gradually depress until the sheet is equally spread: repeat this operation several times until the air-bubbles disappear, taking also the precaution to keep the upper side of the paper dry. Let the sheet remain upon the slab until the formation of the chloro-bomo-iodide of silver is perfect. This may be known by the disappearance of the violet color, which the back of the paper at first presented: it must not be left longer, otherwise it would lose its sensitiveness. The time required to effect this chemical change is from one to five minutes, depending upon the quality of the paper.

Spread upon a glass, fitted to the frame of the camera, a piece of white paper well soaked in water; upon this place the prepared sheet, the sensitive side upwards.

MR. THOMAS'S METHOD.

Select old and thin English paper—I prefer Whatman's—and cut it to the size of the frames. Prepare the following solution,—

Saturated solution of iodide of potassium	2½ fl.drachms.
Pure iodine	9 grains.

Dissolve, then add,—

Distilled water	11½ oz.
Iodide of potassium	4 drachms.
Bromide of potassium	10 grains.

and mix. Filter the mixture into a shallow porcelain vessel, and place a sheet of paper carefully on the surface of the fluid, and let it remain about two minutes; if French paper, one minute, or until the iodine tint shows through the paper, which must not be wetted at the back. Hang it up by one corner to drain and dry.

To excite this paper, lay it upon a solution of

Nitrate of silver	2½ drachms.
Acetic acid	4½ "
Distilled water	3½ oz.

This paper is used in the camera by the *wet* method, p. 18.

The object was taken by an achromatic lens of three inches diameter, and half-inch diaphragm; and, if well lighted by the sun, in from four to six minutes' exposure.

The image takes from ten to twenty minutes to develope in a solution of gallic acid. It may be fixed in the usual manner by the hyposulphite of soda, or by a solution of bromide of potassium, ten grains to the ounce of water.

2.—Exciting the Paper for the Camera.

MR. H. CUNDELL'S PROCESS.

For this purpose are required two solutions, as described by Mr. Talbot,—viz., a saturated solution of crystallised gallic acid in cold distilled water, and a solution of nitrate of silver, of the strength of fifty grains to the ounce of distilled water; to which is added one-sixth part of its volume of glacial acetic acid. For many purposes these solutions are unnecessarily strong, and, unless skilfully handled, they are apt to stain or embrown the paper; where extreme sensitiveness, therefore, is not required, they may with advantage be diluted to half the strength, in which state they are more manageable, and nearly as effective. The gallic-acid solution will not keep for more than a few days, and only a small quantity, therefore, should be prepared at a time. When these solutions are about to be applied to the iodised paper, they are to be mixed together in equal volumes, by means of a graduated drachm tube. The mixture is called "the gallo-nitrate of silver." As it speedily changes, and will not keep more than a few minutes, it must be used without delay; and it ought not to be prepared until the operator is quite ready to apply it.

The application of this "gallo-nitrate" to the paper is a matter of some nicety. It will be found best to apply it in the following manner:—Pour out the solution upon a clean slab of plate-glass, diffusing it over the surface to a size corresponding to that of the paper: holding the paper by a narrow, upturned margin, the sensitive side is to be applied to the liquid upon the slab, and brought in contact with it by passing the fingers gently over the back of the paper, which must not be touched with the solution.

As soon as the paper is *wetted* with the gallo-nitrate, it ought instantly to be removed into a dish of water: five or ten seconds at the most is as long as it is safe, at this stage, to leave the paper to be acted upon by the gallo-nitrate; in that space of time it absorbs sufficient to render it exquisitely sensitive. The excess of gallo-nitrate must immediately be washed off, by drawing the paper gently several times under the surface of water, which must be perfectly clean; and, being thus washed, it is finished by drawing it again through the fresh water two or three times. It is now to be dried in the dark, and, when the surface is dry, it may either be placed, while still damp, in the camera, or in a portfolio among blotting-paper, for use. If properly prepared, it will keep perfectly well for four-and-twenty hours at least, retaining all its whiteness and sensibility.

3.—Exposure in the Camera.

MR. CUNDELL'S PROCESS.

The exposure in the camera, for which, as the operator must be guided by his own judgment, few directions can be given, and few are required. He must choose or design his own subject: he must determine upon the aperture to be used, and judge of the time required, which will vary from a few seconds to three or four minutes. The subject ought, if possible, to have a strong and decided effect; but extreme lights, or light-coloured bodies, in masses, are by all means to be avoided. When the paper is taken from the camera, very little or no trace whatever of a picture is visible, until it is subject to the fourth process, which is—the Bringing out of the Picture.

4.—Bringing out the Picture.

MR. H. CUNDELL'S METHOD.

The development of the picture is effected by again applying the "gallo-nitrate" as before directed (p. 40.) As soon as the paper is wetted all over, unless the picture appears immediately, it is to be exposed to the *radiant* heat from a smoothing iron, or any similar body, held within an inch or two by an assistant. It ought to be held vertically, as well as the paper; and the latter ought to be moved so as to prevent any one part of it becoming dry before the rest.

As soon as the picture is sufficiently brought out, wash it immediately in clean water to remove the gallo-nitrate, as directed (p. 40); it may then be placed in a dish by itself, under water, until you are ready to fix it. The most perfect pictures are those which

come out before any part of the picture becomes dry, which they will do if sufficiently impressed in the camera. If the paper be allowed to dry before washing off the gallo-nitrate, the lights sink and become opaque; and if exposed in the dry state to heat, the paper will embrown; the drying, therefore, ought to be *retarded*, by wetting the back of the paper, or the picture may be brought out by the vapour from hot water, or, what is better, from a horizontal jet of steam.

5.—Fixing the Picture.

MR. H. CUNDELL'S METHOD.

The fixing of the picture is accomplished by removing the sensitive matter from the paper. The picture, or as many of them as there may be, is, to be soaked in warm water, but not warmer than may be borne by the finger; this water is to be changed once or twice, and the pictures are then to be well drained, and either dried altogether, or dressed in clean dry blotting-paper, to prepare them to imbibe a solution of the hyposulphite of soda, which may be made by dissolving an ounce of that salt in a quart of water. Having poured a little of the solution into a flat dish, the pictures are to be introduced into it one by one; daylight will not now injure them; let them soak for two or three minutes, or even longer, if strongly printed, turning and moving them occasionally. The remaining unreduced salts of silver are thus thoroughly dissolved, and may now, with the hyposulphite, be entirely removed by soaking in water, and *pressing* in clean white blotting-paper, alternately; but if time can be allowed, soaking in water alone will have the effect in twelve or twenty-four hours, according to thickness of the paper.

It is essential to the success of the fixing process that the paper be, in the first place, thoroughly penetrated by the hyposulphite, and the sensitive matter dissolved: and next that the hyposulphite compounds be effectually removed. Unless these salts are completely removed, they induce a destructive change upon the picture, they become opaque in the tissue of the paper, and entirely unfit it for the next, or printing process.

6.—The Printing Process.

The picture being thus fixed, it has merely to be dried and smoothed, when it will undergo no further change. It is, however, a *negative* picture, and if it have cost some trouble to produce it, that trouble ought not to be grudged, considering that

you are now possessed of a matrix which is capable of yielding a vast number of beautiful impressions.

The manner of obtaining these impressions has been so often described, and there are so many different modes of proceeding, that it may be sufficient to notice very briefly the best process with which I am acquainted. Photography is indebted for it to Dr. Alfred S. Taylor. This solution is made by dissolving one part of nitrate of silver in twelve of distilled water, and gradually adding some strong liquid ammonia until the precipitate at first produced is at length *just* re-dissolved.

Some paper is to be met with containing traces of bleaching chlorides, which does not require any previous preparation; but in general it will be found necessary to prepare the paper by slightly impregnating it with a minute quantity of common salt. This may be done by dipping it in a solution in which the salt can scarcely be tasted, or of the strength of from thirty to forty grains to a pint of water. The paper, after being pressed in clean blotting-paper, has merely to be dried and smoothed, when it will be fit for use.

The ammonia-nitrate of silver is applied to the paper in the manner described in Section 3; and when perfectly dry the negative picture to be copied is to be applied to it, with its face in contact with the sensitive side. The back of the negative picture being uppermost, they are to be pressed into close contact by means of a plate of glass; and thus secured, they are to be exposed to the light of the sun and sky. The exposed parts of the sensitive paper will speedily change to lilac, slate-blue, deepening towards black; and the light gradually penetrating through the semi-transparent *negative* picture, will imprint upon the sensitive paper beneath a *positive* impression. The negative picture, or matrix, being slightly tacked to the sensitive paper by two mere particles of wafer, the progress of the operation may from time to time be observed, and stopped at the moment when the picture is finished.

It ought, then, as soon as possible, to be soaked in warm water, and fixed in the manner described in Section 14.

MR. MILLER'S PROCESS.

Prepare the paper by floating it in a solution of fifteen grains of nitrate of lead in an ounce of water. It is then placed on a solution of ten grains of iodide of iron to an ounce of water; left two minutes and blotted off. The paper, whilst moist, is rendered sensitive by a solution of nitrate of silver, 100 grains to an ounce of water, and placed in a camera. After exposure

the image gradually developes itself without any further application, and is fixed by hyposulphite of soda. This is a most striking discovery, as it supersedes the necessity of any developing agent after the light has acted on the paper.

MR. STEWART'S PROCESS.

The following observations are confined to negative paper processes, divisible into two—the *wet* and the *dry*. The solutions I employ for both these processes are identical, and are as follows:—

Solution of iodide of potassium, of the strength of 5 parts of iodide to 100 of pure water.

Solution of aceto-nitrate of silver, in the following proportions: 15 parts of nitrate of silver; 20 of glacial acetic acid; 150 of distilled water.

Solution of gallic acid, for developing; a saturated solution.

Solution of hyposulphite of soda; the strength of 1 part hypo. of soda to from 6 to 8 parts water.

The solutions employed are thus reduced to their simplest possible expression, for it will be observed that in iodizing I employ neither rice-water, sugar of milk, fluoride, cyanuret, nor free iodide, &c., &c.; but a simple solution of iodide of potassium. [The *strength* of this solution is a question of considerable importance, not yet, I think, sufficiently investigated.]

For both the wet and the dry processes I iodize my paper as follows:—In a tray containing the above solution I plunge, one by one, as many sheets of paper (twenty, thirty, fifty, &c.) as are likely to be required for some time. This is done in two or three minutes. I then roll up loosely the whole bundle of sheets, while in the bath; and picking up the roll by the ends, drop it into a cylindrical glass vessel with a foot to it, and pour the solution therein, enough to cover the roll completely (in case it should float up above the surface of the solution, a little piece of glass may be pushed down to rest across the roll of paper and prevent its rising). The vessel with the roll of paper is placed under the receiver of an air-pump, and the air exhausted; this is accomplished in a very few minutes, and the paper may then be left five or six minutes in the vacuum. Should the glass be too high (the paper being in large sheets) to be inserted under a pneumatic pump-receiver, a stiff lid lined with India-rubber, with a valve in the centre communicating by a tube with a common direct-action air-pump, may be employed with equal success. After the paper is thus soaked *in vaccuo* it is removed, and the roll dropped back into the tray with the solution, and then,

sheet by sheet, picked off and hung up to dry, when, as with all other iodized paper, it will keep for an indefinite time.

I cannot say that I fully understand the rationale of the action of the air-pump, but several valuable advantages are obtained by its use:—1st. The paper is thoroughly iodized, and with an *equality* throughout that no amount of soaking procures, for no two sheets of paper are alike, or even one, perfect throughout in texture; and air-bubbles are impossible. 2d. The operation is accomplished in a quarter of an hour, which generally employs one, two, or more hours. 3d. To this do I chiefly attribute the fact that my paper is never solarized even in the brightest sun; and that it will bear whatever amount of exposure is necessary for the deepest and most impenetrable shadows in the view, without injury to the bright lights.

Wet Process.—To begin with the *wet* process. Having prepared the above solution of aceto-nitrate of silver, float a sheet of the iodized paper upon the surface of this sensitive bath, leaving it there for about ten minutes. During this interval, having placed the glass or slate of your slider quite level, dip a sheet of *thick* clean white printing (unsized) paper in water, and lay it on the glass or slate as a wet lining to receive the sensitive sheet. An expert manipulator may then, removing the sensitive sheet from the bath, extend it (sensitive side uppermost) on the wet-paper lining, without allowing any air-globules to intervene. But it is difficult; and a very simple and most effectual mode of avoiding air-globules, particularly in handling very large sheets, is as follows:—Pour a layer of water (just sufficient not to flow over the sides) upon the lining paper, after you have extended it on a glass or slate, and then lay down your sensitive paper gently and by degrees, and floating as it were on the layer of water; and when extended, taking the glass and papers between the finger and thumb, by an upper corner to prevent their slipping, tilt it gently to allow the interposed water to flow off by the bottom, which will leave the two sheets of paper adhering perfectly and closely, without the slightest chance of air-bubbles;—it may then be left for a minute or two, standing upright in the same position, to allow every drop of water to escape; so that when laid flat again or placed in the slider none may return back and stain the paper. Of course, the sensitive side of the sheet is thus left exposed to the uninterrupted action of the lens, no protecting plate of glass being interposed,—and even in this dry and warm climate I find the humidity and the attendant sensitiveness fully preserved for a couple of hours.

To develope views thus taken, the ordinary saturated solution of gallic acid is employed, never requiring the addition of nitrate of silver; thus preserving the perfect purity and varied modulation of the tints. The fixing is accomplished as usual with hyposulphite of soda, and the negative finally waxed.

Dry Process.—In preparing sheets for use when *dry* for travelling, &c., I have discarded the use of *previously waxed* paper, thus getting rid of a troublesome operation,—and proceed as follows:—Taking a sheet of my iodized paper, in place of floating it (as for the wet process) on the sensitive bath, I plunge it fairly into the bath, where it is left to soak for five or six minutes; then removing it, wash it for about twenty minutes in a bath, or even two, of distilled water, to remove the excess of nitrate of silver, and then hang it up to dry (in lieu of drying it with blotting-paper.) Paper thus prepared possesses a greater degree of sensitiveness than waxed paper, and preserves its sensitiveness, not so long as waxed paper, but sufficiently long for all practical purposes,—say thirty hours, and even more. The English manufactured paper is far superior for this purpose to the French. To develope these views, a few drops of the solution of nitrate of silver are required in the gallic acid bath. They are then finally fixed and waxed as usual.

These processes appear to me to be reduced to nearly as great a degree of simplicity as possible. I am never troubled with stains or spots, and there is a regularity and certainty in the results that are very satisfactory. You will have observed, too, how perfectly the aerial and perspective gradation of tints are preserved—as also how well the deepest shadows are penetrated and developed—speaking, in fact, as they do to the eye itself in nature. In exposing for landscape, I throw aside all consideration of the bright lights, and limit the time with reference entirely to the dark and feebly-lighted parts of the view; with a $3\frac{1}{4}$ inch lens: the time of exposure has thus varied from ten minutes to an hour and a half, and the action appears to me never to have ceased.

The influence of the air-pump in this appears to me very sensible, and deserving of further examination and extension. I purpose not only iodizing, but rendering the paper sensitive with the action of the air-pump, by perhaps suspending the sheet after immersion in the nitrate bath under the receiver of the air-pump for a few minutes, before exposure in the camera, or by some other manœuvre having the same object in view.

I should say that I have chiefly employed Canson's French paper in iodizing with the aid of the pump. Few of the Eng-

lish manufactured papers are sufficiently tenacious in their sizing to resist the action of the pump, but they may easily be made so; and were, in short, the English paper, so far superior in quality to the French, only better sized, that is with glue less easily soluble, even though more *impure*, there is scarcely any limit to the beauty of the views that might be produced.

There are more minor details that might be given; but I fear repeating many a "twice-told tale," acquainted so little as I am with what is doing;—the preceding, however, may have some interest, and whatever is of value is entirely due to our friend M. Regnault, ever so generously ready as well as able to aid and encourage one's efforts.

SIR WILLIAM NEWTON'S METHOD.

Negatives, on paper prepared with iodide of silver, 20 grains to one ounce of distilled water.

Excited for the camera (weak), containing about two grains of nitrate of silver to one ounce of water.

Exposure to the objects from 5 to 15 minutes, according to the subject and weather. Waxed afterwards.

Positives, on negative paper, containing from 7 to 10 grains of iodide of silver to one ounce of distilled water.

Brought out in the same manner as the negatives, with a saturated solution of gallic acid, and finished with 5 grains of aceto-nitrate to one ounce of water.

Excited with 5 grains of aceto-nitrate to one ounce of water, and exposed to the light in a frame five seconds to half a minute, according to the light and transparency of the negative.

NOTATION TO CHEMISTRY.

Notwithstanding the great advantages of the chemical nomenclature, a much greater help is given to the student in the notation. By this, as in Algebra, long and intricate processes are exhibited to the eye at a glance, and the relations of the constituents in complicated compounds easily comprehended. Each element is represented by a symbol consisting of its initial, or in the case of two or more which have the same initial, of the initial and one of the following letters, as at the end of this article, where the symbols of all the elementary substances are given. In the case of potassium, sodium, tin, iron, and several others, the symbols are derived from the Latin names.

The symbols of compounds are composed of the symbols of their constituents, algebraically connected; as Fe+Cl, chloride of iron. In primary compounds the sign + is often omitted.

Coefficients are used to show the number of equivalents, as N+4Cl, quadrochloride of nitrogen; or if several symbols are written together without the sign +, an index is substituted for the coefficient, because the coefficient multiplies all which come between it and the next sign. Thus the symbol of the substance last mentioned may be written, NCl^4.

Cyanogen, ammonia, and water, although compounds, have simple symbols like the elements; thus we have Cy, Am, and Aq *(Aqua)*, instead of NC^2, H^3N, and HO.

The symbols of oxygen and sulphur are abbreviated. The symbols for the compounds of oxygen, are written thus :

$\dddot{N}$ for N+5O, $\ddot{N}$ for N+4O, $\dot{N}$ for N+3O, etc., each dot indicating an equivalent of oxygen. A comma is used in the same manner for the compounds of sulphur, thus $\dot{P}$ for PS. In place of the coefficient 2, a dash is often drawn through or beneath the symbol. This is very convenient in the case of half equivalents; as $\underline{\dddot{Mn}}$, signifying 2Mn+3O, that is Mn+$1\frac{1}{2}$O, sesquioxide of manganese. In compounds of complicated constitution, it is often necessary to multiply several terms by one number, or to connect them as a whole to another term. This is done as in algebra, by the use of the vincula or parentheses; thus $(\dot{K}+2\dddot{S})$ +Aq, shows that Aq is combined with $\dot{K}+2\dddot{S}$, as with one substance; but if the parentheses were omitted, thus $\dot{K}+2\dddot{S}+Aq$, the symbol would indicate a combination of three distinct substances, each one with the other. Also in $2(\dot{K}+2\dddot{S})$, the first coefficient belongs to what is within the parentheses as to one substance.

If the student will, for practice, explain the constitution and give the names of the compounds in the annexed table, he will become familiar with the rules of nomenclature and notation.

The following table contains the names, equivalents, and symbols of the thirteen non-metallic elements, and the symbols of their compounds with each other, in the order in which they are described:

Oxygen,	equiv. 8	symbol	O.
Chlorine,	" 35.42	"	Cl, Cl+O, Cl+4O, Cl+5O, Cl+7O.
Iodine,	" 126.3	"	I, I+5O, I+7O, 3Cl+I.
Bromine,	" 78	"	Br, Br+5O, or BrO^5.
Fluorine,	" 18.68	"	F.

Hydrogen,	"	1	"	H, H+O or $\dot{H}$, H+2O or $\ddot{H}$, H+Cl, H+I, H+Br, H+F or HF.
Nitrogen,	"	14.15	"	N, NO or $\dot{N}$, NO^2 or $\ddot{N}$ NO^3 or $\dddot{N}$, NO^4 or $\ddddot{N}$, NO^5 or $\dot{\dot{N}}$, NCl^4, Nl^3, NH^3.
Carbon,	"	6.12	"	C, $\dot{C}$, $\ddot{C}$, C+Cl, C^{4}Cl^5, C^{2}Cl, CCl^3 $\dot{C}$+Cl, CH^2 C^{2}H^2, C^{4}H^4, C^{6}H^3, C^{6}H^5, C^{10}H^4, C^{15}H^6, C^{10}H^8, HCy, CyO, Cy^{3}O^{6}H^3, CyCl, Cy Cl^2, HCyS^2, CyS^2. H^{2}CyS^2.
Sulphur,	"	16.1	"	S, SO^2, SO^3, $\overline{SO^2}$, $\overline{SO^5}$, S^{2}Cl, S Cl, HS, HS^2, CS^2.
Phosphorus,	"	15.7	"	P, P^{2}O, P^{3}O, P^{2}O^3, P^{2}O^5, P^2 Cl^3, P^{2}Cl^5, PI, P^{2}I^3, PBr, P^2 Br^5, H^{3}P^2.
Boron,	"	10.9	"	B, B+3O, B+3Cl, B+3F.
Selenium,	"	39.6	"	Se, Se+O or $\dot{Se}$. Se+2O or $\ddot{Se}$, Se+3O or $\dddot{Se}$.
Silicon,	"	22.5	"	Si, Si+O, SiCl, SiBr, SiS, SiF.